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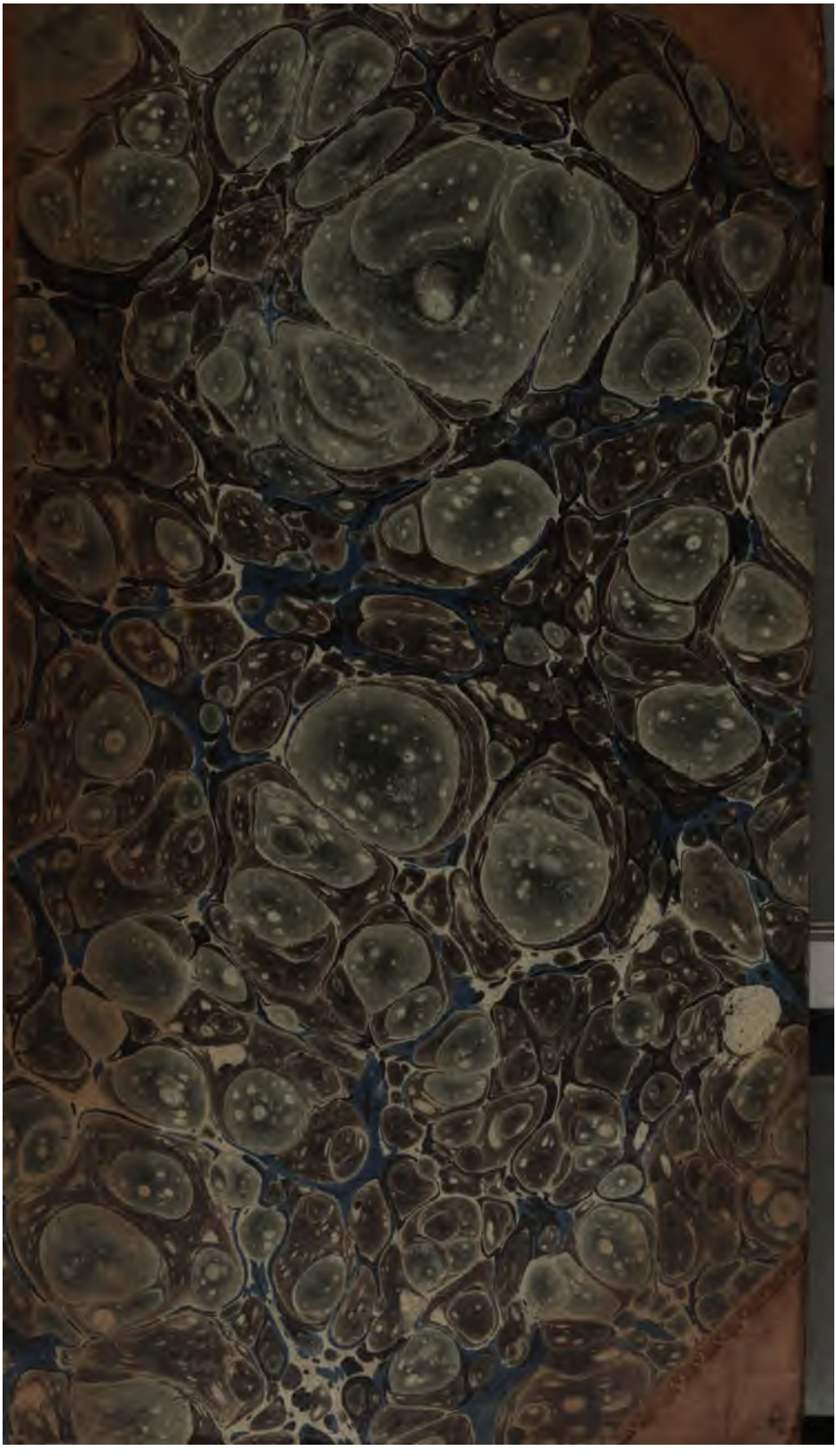

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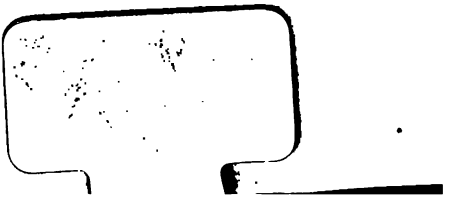

THE

TECHNICAL REPOSITORY.

VOL. IV.

THE

TECHNICAL REPOSITORY,

CONTAINING

Practical Information

ON SUBJECTS CONNECTED WITH

DISCOVERIES AND IMPROVEMENTS

IN THE

USEFUL ARTS.

ILLUSTRATED BY NUMEROUS ENGRAVINGS.

BY THOMAS GILL,

A CHAIRMAN OF THE COMMITTEE OF MECHANICS IN THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE, ADELPHI.

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THE

TECHNICAL REPOSITORY.

I.—*Explanation of the Measures taken to do away with the Inconvenience arising from Copper Smoke. By* J.H. VIVIAN, *Esq.* F.R.S. *&c. With some Observations on other Plans that have been suggested as likely to effect this object.**

WITH A PLATE.

THE smoke produced from a Copper-smelting Work may be considered under two heads, viz. Coal Smoke and Copper Smoke.

Coal smoke consists of the usual products and residue of combustion, as carbonic acid, nitrogen gas, and the incombustible and unburnt portions of coal. These substances, although in themselves noxious when chemically considered, are rendered harmless when diluted with the atmosphere into which they are sent.

Copper smoke, or what may be properly considered under that head, as being peculiar to the operations in a copper work, may be said to consist of the following substances or chemical compounds, formed during the calcining processes by the evolution of substances contained in the ore†:—

1st. Sulphurous acid;
2d. Sulphuric acid;
3d. Arsenic;
4th. Arsenious acid;
5th. Fluoric compounds;
and Mechanical impurities.

* From "The Proceedings of the Subscribers to the Fund, for obviating the Inconvenience arising from the Smoke produced by Smelting Copper Ores." 1823.

† For a detailed account of the component parts of the copper ores, see the article "On Smelting Copper at the Hafod Copper-Works, near Swansea," in Vol. III. p. 145.—EDITOR.

Of the above substances, the two first are formed by the combustion of the sulphur.

The *sulphurous acid*, which is by far the most abundant, is evolved in the state of a pungent and penetrating gas.

The *sulphuric acid*, which is composed of sulphur combined with more oxygen than exists in the sulphurous acid and water, appears as a dense white vapour.

The *arsenical* contents of the copper ores expelled by heat, appear partly as *arsenic*, in the metallic state, partly as combined with oxygen, forming *arsenious acid*, or *white oxide of arsenic:* in both cases it assumes the form of vapour.

The *fluoric compounds* are produced by the decomposition of the fluor spar, or fluate of lime, during the chemical changes occurring in the calcination of the ore. The property of the fluoric acid to act on silica is well known, and probably, if the contents of the flue from the calciners were accurately examined, *silicated fluoric acid gas* and *hydrofluoric acid* would be found.

The *mechanical impurities* consist of the fine particles of the ore, carried over by the draught of the furnaces. They may contain a portion of copper, but the quantity of this is unquestionably very small, as has been fully proved by the deposits obtained from the different chambers; although by the most absurd and exaggerated statements, it has been otherwise represented.

Having thus taken a brief view of the nature of the principal substances contained in the smoke that arises from a copper work, I shall proceed to detail the particular measures which I have adopted for getting rid of its noxious qualities.

The first experiments which I undertook for the attainment of this object, were at Penclawdd, in the year 1810, prior to the removal of our Works from thence. The means employed, consisted simply in constructing lengthened flues, carried horizontally and in angular directions; but I soon discovered, that, although, from the obstructions

presented to the smoke, some deposit was collected in the flue, the object I had in view could not be effected by mechanical means alone.

The difficulty then arose of finding any agent that might be applicable to a working system; for, although by various chemical combinations, it may be shewn in a laboratory, or by experiments on a small scale, that the noxious properties of the smoke may be destroyed; still, with reference to their practical application, numerous important considerations were to be kept in view; such as the great extent of the smelting establishments and of the volume of matter to be acted on,—the various properties of the substances contained in the smoke and the diluted state of the gas,—the cost of the condensing or de-oxidizing agent to be employed, and the possibility of obtaining an adequate supply,—the mechanical means by which it was to be applied,—the difficulty of getting workmen to pay attention to chemical operations,—the great expense and inconvenience that would be attendant on alterations in the construction of the furnaces, a point that, whatever the measures attempted, should never be lost sight of,—together with many others, which it is not necessary here to enumerate. These considerations satisfied me of the necessity of pursuing the most simple plan, as the only one that could be of practical utility to the existing establishments; and I, accordingly, determined on trying the effect of water, for the purposes of condensing and absorbing the gases, vapours, and other substances, contained in the smoke.

It was not, however, until some years after our removal to Hafod, that I could undertake any experiments on a large scale, for want of a command of a sufficient quantity of water.

The first trial worth noticing was in May 1820, when I resumed my experiments. The plan which I had in view, was to pass the smoke from the calciners through a horizontal flue, under the floor of the Works, and thus to avail ourselves of the waste water. I accordingly had a flue of this

description constructed from a calciner, in a detached building in the Works, to a stack in the main range; opening a communication for the admission of water from the gutters that supply the metal pits. This trial failed, owing to the inconvenience experienced by the calciner-men, when stirring or drawing out their charges of ore: for, as it was necessary, on those occasions, to have the doors of the calcining furnace open, the smoke found a more ready vent through these apertures than down the depressed flue. Whilst the doors of the calciner were closed, the draught was good, and the ore well calcined. In order, then, to remedy the defect in the draught, when the doors were open, I determined on constructing a horizontal flue, above the level of the flues leading from the calciners; but the difficulties of arranging a plan for carrying it through the Works, without inconvenience to the furnace-men, were so great, that they appeared almost insuperable. After a lapse, however, of some months, the difficulty as to the water was overcome, by purchasing the Forest Rolling Mills, situated on the river, which enabled us, by depriving those mills of a part of their supply, and delivering it into the canal, to surmount any objection to our receiving from thence an additional quantity. Accordingly, in the month of March, 1821, the trials at Hafod were resumed, and on a scale that was certain to lead to decided results. A large horizontal flue was constructed, which passed through the interior of the Work on arches; and being thus raised above the door-ways, the workmen were not incommoded, nor was there any material reduction in the space opposite their furnaces.

This flue was continued in a straight line on the outside of the Works, for the distance of about one hundred yards, where a stack was erected of one hundred feet in height; and in the flue between the Works and the stack was a large chamber, for the purpose of checking the passage of the smoke, and thus permitting the deposit of any matters held in mechanical suspension. The accompanying

drawings will shew the elevation of the stack, and the general arrangement of the flues, &c.

The stack was begun in the end of May, and finished the middle of July, 1821. It is $6\frac{1}{2}$ feet square in the clear at the bottom, and four feet at the top. The sides are three bricks in thickness at the base, and half a brick at the summit; the sets-off are on the inside, and the taper is 3-8ths of an inch per foot in height on each side. It is built on a foundation of slags, covering a marsh, but, owing to the precautions taken in forming the foundation, no material settlement has taken place.

The horizontal flue within the Works was built with a trifling rise to the outer wall, where the first jet of water was introduced; and from that point it had a gentle fall towards the stack; so that water, admitted from the different jets into the flue and chamber, might flow in the same direction as the smoke, and thus assist rather than impede the draught.

The water was introduced into the flue by iron pipes, laid across the bottom, and communicating with a range of pipes from the canal. In the upper side of these pipes several holes were drilled; and in the top of the flue, immediately above them, were fixed iron plates. This arrangement was made under the impression that the water, having a twelve-feet head, would be thrown with considerable force against the plates; and being thus dispersed, would, whilst falling like a shower, be traversed by the smoke. Each cross-pipe was furnished with a cock, that those jets might be allowed to play that were found in practice to have the greatest effect, as being nearest to, or farthest from, the calciners. Four pipes were laid across the chamber, and at the upper end of it a bridge was constructed to arrest the progress of the smoke, and thus expose it to the action of the water.—See Plate I. fig. 1.

In August 1821, this flue was so far completed that the ten calciners in the main building were turned into it, and the result was highly satisfactory. The volume of smoke

was very considerably diminished, and the nature of that which passed off from the high stack was most materially altered, as the great deposit on the sides of the flue, and in the bottom of the stack, evidently proved; added to this, the water that was thrown into the flue and chamber was highly impregnated with the substances abstracted from the smoke; and, indeed, persons who had opportunities of breathing the smoke from the stack, when distinct from that of other Works, pronounced it to be no longer in any material degree offensive.

This plan of introducing the water was, however, in practice incomplete; for although we had a head of water of twelve feet, the water, owing to the great length of pipe from the canal, the smallness of the bore (it being only three inches in diameter), and the numerous angles it had to pass through, had lost so much of its momentum, that it did not ascend with that force which was required to produce the intended effect. It was determined, therefore, to adopt the form of a shower bath, admitting the water into the top of the chamber and flue, through a copper pan pierced with holes, and thus insuring its regular distribution.

I had proceeded thus far in my endeavours to remedy the inconvenience, when, in October 1821, to my great surprise, a bill of indictment was preferred against us at the Quarter Sessions at Swansea, where it was thrown out by the Jury. Prior to this proceeding upwards of 1200*l.* had been expended in the preceding six months.

In pursuance of our objects, arrangements were next made for connecting a range of calciners in another part of the Works with the stack, by a second flue. In the construction of the chambers attached to this flue, I caused vertical divisions to be made, by which the smoke was brought into more immediate contact with the water, and exposed to the action of repeated falls; as is shewn in the accompanying section. I also determined on laying down a range of pipes, of seven inches bore, so as to secure an ample supply of water. And, as I had found, in my former

trials, that the melting furnaces would not heat when introduced into the same flue with the calciners, I decided on building a separate flue for the melters, and to admit it into the stack, either through a separate opening or immediately after its junction with the calciner flue.

My object in building this flue for the melting furnaces, was to try the effect of the high stack on the draught of those furnaces, and also to enable us to reduce the temperature of the calciner flue for the purpose of condensation; as the heat of the furnace flue, it was expected, would preserve the draught in the stack after the smoke had passed the chambers*.

This additional flue, owing to the badness of the weather, could not be completed before the month of January. In the beginning of this month, when not less than 2800*l.* had been expended in these trials and works, and that I had requested the attendance of Mr. R. Phillips, at Swansea, to consult as to any farther operations, the bill of indictment was re-preferred at Cardiff, and found. I notice this in order to shew, that, although the bill had been thrown out at Swansea, we had not in any way desisted from our endeavours to do away with the inconvenience complained of. About the end of the month of January, Mr. Phillips attended at Swansea, and by his visit satisfied me that the measures I had taken, and proposed taking, included every thing that appeared likely to be effectual, as he had previously assured me in London.

Thus encouraged, we continued our labours, made additional chambers and extended our flues, so as to include all the calciners in the Works. The internal arrangement of the chambers in the ore calciner flue, and the course of the

* It is here, perhaps, necessary to explain, that it is from the calcining furnaces that the noxious matter chiefly arises; in them it is, that the ore and metallic sulphurets are exposed to a moderate heat, for the purpose of expelling the sulphur and arsenic; whereas, in the melting furnaces, the object is to bring the substances as soon as possible into fusion, and, consequently, the quantity of matter liberated before that is effected must be very trifling; that which issues from the chimney of a melting furnace is almost entirely coal smoke.

smoke, are shewn in the accompanying elevation, fig. 2. The perpendicular height of shower in the four chambers was calculated to be 480 feet.

This plan continued in operation for some months, when it was found that several of the partitions in the chambers, having been built of the thickness of only half a brick, had given way, owing to the action of the acids on the mortar and materials, and that a general repair was necessary. In carrying this into effect some alterations were made in the arrangement of the partitions, reducing the number in some of the chambers, and making the passage for the smoke at the ends, so that it might traverse the chamber horizontally instead of being forced to ascend against the showers, and to descend below the level of the calciners, which naturally tended to impede the draught. And as the copper troughs, of which there was one to each division, had been found to be injured by the smoke with which they were surrounded, and the numerous apertures for passing these troughs in and out, admitted atmospheric air; the effect of which was to diminish the draught, whilst the operations within the chambers could not be well overlooked, or the distribution of the water regulated; the whole chamber has been covered with a large copper cistern, pierced with holes in the bottom in those parts corresponding with the current of the smoke. This arrangement remedied all the inconveniences we had experienced. The depth of water in the cistern acts as its own regulator; as the greater the head, the greater the velocity with which it is forced through the holes; and the escape of smoke on admission of air, is effectually prevented by the body of water which covers the only apertures.

The copper of which these cisterns are formed is of the substance of about 3 lbs. to the foot; the holes are placed in diagonal lines, about an inch apart, and a square foot of surface contains about 250 holes. The openings are as small as they can be made, so as to admit the passage of the water, in order that, by having the drops small, as much

surface as possible may be exposed; their diameter may be about No. 17 of the wire-guage, or 1-16th of an inch. The copper is laid over the chamber with the burr of the holes downwards, as allowing more readily of the formation of the drop; and the arrangement of the holes is such, that the smoke that escapes one line, is brought in contact with the shower from the next.

Another change that it has been found useful to make, has been that of turning back, into their own stacks, the melting furnaces which were connected with the upper horizontal flue leading to the great stack; as the furnaces, whilst drawing into this general flue, did not heat sufficiently quick or strong, to do their usual quantum of work. This was, probably, owing to various causes, as the great length of the horizontal flue, and inadequate height of the stack—the admission of external air, which it was impossible totally to exclude, the building materials themselves being in a degree porous—and the depression of the flue, although trifling, before its entering the stack; perhaps, also, the stack itself being of too small dimensions. I have before observed, that the smoke from a melting furnace could contain but a small proportion of noxious matter, from the nature of the operation; and, therefore, I less regretted the necessity of the alteration, particularly as we found that the principal object that we had in view, in constructing the upper flue in the first instance, namely, the preservation of the draught in the calciner flue after the condensing processes, could be effected by a single melting furnace drawing directly into the stack.

The arrangements have now been completed and at work for some months; and, at the same time that the effect on the smoke has been most beneficial, the most noxious parts of it having been totally arrested, and much of the more disagreeable but less noxious gas being absorbed, it is highly satisfactory to be able to state, that the operations in the work suffer no impediment or inconvenience. The draught of the calciners is as good as can be wished, and the only additional current expense, is the cartage of fuel

and slag to the melting furnace at the stack, it being at some distance from the rest of the Works; and even this expense might have been avoided had the high stack been placed in a more convenient situation for the melting and calcining furnaces.

The following results of the experiments of Messrs. Phillips and Faraday, which are annexed to this statement, will shew the ground on which I have ventured confidently to assert, that the most noxious parts of the smoke have been totally arrested, and the desired effect of doing away the inconvenience arising from it, for the most part, if not entirely, attained.

It appears from experiments 2, 3, and 4, that *metallic arsenic* is deposited in the shower chambers, and is found in abundance floating in the water in the trough.

The *arsenious acid*, see experiments 3, 4, 5, 6, 7, and 8, is in part deposited, and in part dissolved by the water, and any small portion of *arsenic acid* which may be formed at a high temperature, is also very readily dissolved by the water, in which it is even more soluble than the arsenious acid. The efficacy of the water is further proved, by there being only a trace of arsenic in the flue, after the smoke has passed the shower chambers.

The *sulphuric and hydro-fluoric acids* are, like the arsenious, carried over in the æriform state, and are readily absorbed by water; so is likewise a large portion of the *sulphurous acid*; but being less absorbable than the sulphuric and fluoric acids, a portion of it escapes. The experiments 10, 11, 12, 13, 14, 17, 19, 27, 28, 29, and 32, shew the quantity of sulphur contained in a gallon of water, in the state of sulphurous and sulphuric acids*.

The *fluoric acid*, which was detected by its action on glass† in the flue before entering the shower chamber, was not found after the smoke had passed the washers.

* Water, at ordinary temperatures, will absorb about thirty times its bulk of sulphurous acid gas.

† From subsequent experiments, I am induced to believe, that the cloudiness produced by the smoke on glass is scarcely to be attributed to the action of the fluoric compounds, but is chiefly occasioned by a deposit on the surface; and that, where any chemical action does take place, it is produced by the sulphurous or sulphuric acid combining with the potash

As to any substances carried over *mechanically*, nothing of this nature could possibly escape such a washing as the smoke is here exposed to; and indeed the whole inner surface of the flue, beyond the chambers, is wet, and the bottom covered with slime.

Having thus shewn what is done by the agency of water, and the mechanical means by which it has been applied, I shall proceed to offer a few remarks on the other modes that have occurred to me, or been suggested by others, as calculated to effect the desired object.

1st. STEAM.

Steam might be supposed to act in two ways; first, as inducing the formation of sulphuric acid from the sulphurous; and, secondly, as finely divided water, at the moment of its condensation.

Considering the nature of our great enemy, the sulphurous acid gas, I confess I had no expectation of the efficient action of steam as a chemical agent, but as water in a state of minute division; and thus intimately mixed with the sulphurous acid gas, I thought, that, at the moment of condensation, it might have a powerful effect; and, at all events, I was determined to give it a fair trial. Accordingly, not satisfied with generating steam from a pan containing water,

potash or lead. The experiments which lead to this conclusion were the following:—Several pieces of Scotch white glass were suspended in different parts of the flue, and exposed to the current of smoke during a period of three weeks. The piece placed in the flue, with which the calciners were connected, before the smoke was subjected to any washing, was covered with a white deposit, which was easily scraped off with a knife, and the glass remained perfect. It was in this flue that the fluoric compounds were to be looked for, from the presumed decomposition of the fluor spar in the ore. The glass, from the metal calciner flue, in which there could, probably, be no fluoric acid, was coated with a still thicker deposit than that in the ore calciner flue; and the glass beneath it was evidently decomposed, and could not be restored to any degree of transparency by any process we could employ. It is, however, highly satisfactory to add, that whatever was the cause of this effect on the glass, it was removed by the shower chambers; as pieces, placed at the same time in the flue beyond the washers, were found, at the expiration of three weeks, as transparent as when they were first put there. It is also proper to state, that the heat is much higher in the metal, than in the ore calciner flue.

and placed at the bottom of the flue, at its hottest part, and kept constantly supplied from a cistern on the outside, by means of a float acting on a ball-cock; I had a boiler constructed for the purpose, and a volume of steam, equal to 350 cubic feet per minute, thrown into the flue, in advance of the first shower chamber. On examination, however, of the water from the chamber, before and after the steam was let into the flue, it was found that the proportion of sulphur in each was nearly the same, shewing that the increased effect of the water, in a state of minute division, was fully counterbalanced by the increased temperature; as the thermometer, placed in the water which was discharged from the chamber, rose rapidly, on the steam being admitted into the flue.—See experiments 14, 15, 16, 17, 18, 20; 30, 31, 32, 33.

It is scarcely requisite to observe, that sulphurous acid gas, like every other gaseous body, is less soluble in *hot* water than in *cold*; and although hot water would dissolve the *sulphuric* and *arsenious* acids, yet no advantage results from the use of it, inasmuch as cold water is fully adequate to the purpose; and therefore the trouble and expense of converting the water into steam, which would be considerable, would be unattended by any one equivalent benefit. I was convinced, therefore, that steam could not, in any way, be more advantageously used than water, as I had employed it; even if the difficulties and expenses of application were not so much greater, which they really are.

2d. LIME.

With this substance, I have made some experiments, and I am satisfied it can never be employed on a large scale.

I had an iron trough fixed to the wall of one of the shower chambers; into this lime was put, and mixed with water, till it became of the consistence of cream; and in this state, and also in that of lime-water, it was passed in showers into the chamber; the first portions being applied to the smoke, in its most diluted state, and so passed on,

as it became impregnated, to the stronger smoke; it being returned, by means of a pump, after each operation.—See experiments 21 & 22.

The first objection to this, the only effectual mode of using lime, is the difficulty of insuring the proper attention of the workmen at night, and when they are not overlooked. 2dly. The inconvenience and expense of exposing the lime-water to the action of the smoke, and the difficulty of so mixing the lime with the water, as to prevent the holes of the shower-pans from being stopped up. 3dly, The great expense of the lime itself. And, 4thly, The embarrassment to the Works, from the enormous bulk of lime that would be required.

On the supposition that the whole of the sulphurous acid is to be combined with lime, and the whole of the lime with sulphurous acid (which last consideration is favourable to the calculation, because it is supposing an impossibility in practice, that no lime is wasted); that the limestone is quite pure and well burnt; the Hafod Works would consume about 106 tons of lime every week, which would require for the production, 190 tons of limestone: moreover, to convert the above quantity of lime into lime-water, will require 750 times its weight of water; added to this, sulphate of lime, according to Dr. Thompson, requires 800 times its weight of water to dissolve it; so that, in addition to the procuring 200 tons of limestone weekly—the burning it into 106 tons of lime—the slacking it into 140 tons of hydrate of lime (for it takes up one third of its weight of water)—the dissolving it in 80,000 tons of water (if applied as lime-water), 226 tons of sulphate of lime must either be removed, or dissolved weekly, (requiring for its solution, 180,000 tons of water); and, lastly, there is the expense of exposing this enormous quantity of lime, or lime-water, to the action of the sulphurous acid gas. It is farther to be observed, that, in the above calculations, no allowance is made for the carbonic acid, which is contained in the smoke, and with which the lime would combine, as well as with the sulphurous

acid; so that the quantity of lime required, is almost incalculable.

3d. NITRE.

The use of this article very early occurred to me; but the great expense which it would occasion, always seemed to forbid its application to the extent necessary; and the possibility of any adequate advantage being derived from it did not occur to me, until suggested by Mr. Phillips.

The principle upon which its use would depend is the following:—Sulphurous acid contains less oxygen than sulphuric acid; and although the sulphurous acid has great affinity, for such an additional quantity of oxygen, as would convert it into sulphuric acid, yet it takes it very slowly from atmospheric air; when, however, nitre is decomposed by sulphuric acid, nitric and nitrous acids are given out, in the aëriform state; and if the vapour of water be present, the sulphurous acid so acts upon the nitrous acid, as to decompose it, and take away part of its oxygen. By this *gain* of oxygen, and by combination with water, the sulphurous acid becomes sulphuric acid, and is absorbed by the water, placed for the purpose. On the other hand, the nitrous acid, by the *loss* of oxygen, is reduced to the state of nitric oxide; and this oxide, having a strong disposition to combine with oxygen, takes it from the air, and is reconverted to the state of nitrous acid; so that there is a constant series of compositions and decompositions going on,—the *nitric oxide* being the carrier of oxygen *from* the air *to* the sulphurous acid.

During Mr. Phillips's stay with me last autumn, a leaden chamber was constructed near the horizontal flue, and arrangements made for passing the copper-smoke into it, and introducing nitrous acid, from a retort placed at the end of the leaden chamber.

The result of this experiment was adverse to any hopes that might have been entertained of its success; and it was found, as I always suspected, that the sulphurous acid gas in the flue was too much diluted with the residue of com-

bustion (nitrogen and carbonic acid gas), to be advantageously employed in the manufacture of sulphuric acid*; and that the rapidity of the current was too great to allow of the intimate mixture and condensation of the sulphurous and nitrous vapours; and, consequently, a large portion of the latter was carried off unemployed.—Mr. Hills, a manufacturer of oil of vitriol, is of opinion, that he can overcome these difficulties; but, I confess, I very much doubt it; at least, that any practical benefit can arise; for with us, the manufacture of the acid must always be a secondary consideration; the first, and main point to be attended to, being the preservation of the draught of the furnaces. It is, indeed, true that the process actually employed by Mr. Hills, in his manufacture of oil of vitriol, partly consists in converting the sulphurous acid, generated from burning a metallic sulphuret, into sulphuric acid; but as his sole object is, to procure sulphuric acid, the acid gases are suffered to mix, and act quietly, in leaden chambers, with but very little draught through them: an arrangement, very different indeed to any thing that could be practised in a Copper Work.

4th. Heat. Charcoal.

In order to try the effect that would be produced by passing copper-smoke through fire, I had an experimental furnace constructed near the large stack; into which, by means of a small flue communicating with the horizontal flue from the calciners, and furnished with a damper, I could, by closing the damper in the general flue, introduce the smoke, after it had passed the shower chambers. This flue terminated under the grate of the furnace, so that the smoke which passed along it might ascend through the

* In fact, according to the analysis of Messrs. Phillips and Faraday, the air, or smoke in the flue, at the nearest point to the calciners, does not contain above 5 per cent. of the sulphurous acid gas; which, I should conceive, to be very little more than is contained in the residuary mixture, which issues from the chimney of an oil of vitriol manufactory, after the process is completed.

fire, and from thence into a second flue with a chimney at the end of it.—The plan and section, fig, 2, will give some idea of this arrangement.

My first experiment in this furnace, was with a common coal-fire. The result was, that when the fire was of sufficient thickness, to cause the gas and fuel to come in contact with each other, the smoke could not be passed through it; and that, when the fire on the grate was so thin or open, as to admit a free passage, the smoke was merely heated, and thereby rendered transparent for the moment, but remained undecomposed; at least, if any decomposition took place, the gas was immediately reproduced; for it was evident to the senses, at the top of the stack.

I repeated this experiment with stone-coal, culm and coke, and with the same result.

After witnessing Mr. Bevington Gibbins's experiments*, of passing the smoke through heated charcoal, with the intention of decomposing the sulphurous products, I made repeated trials of the same in this furnace; and the result proved to me the total inutility of the scheme.

The chemical principles, on which Mr. Gibbins's plan is founded, were well illustrated by the experiments he made at the Rose Company's Works. The process consisted, in causing the sulphurous compounds of the smoke, and carbon, to act upon each other, at a high temperature; when, the affinity of the carbon for oxygen, is so much greater than that of sulphur for the same body, that the sulphurous compounds are decomposed, sulphur is liberated, and carbonic oxide, and perhaps, also, carbonic acid, in small quantities, are formed.

* This Gentleman will, I trust, excuse my remarking on the plan proposed by him; and will do me the justice to believe, that one motive only has induced me to do so—*a desire, "by inquiry and examination, to ascertain that method, which can but be practically adopted, for effecting the object we all have in view."* No one is more ready than I am, to give full credit to Mr. Gibbins, for the ingenuity and zeal with which he has devised and pursued his experiments. But if (as I confess it appears to me) it is totally impossible to carry into practice the means proposed by him, Mr. G. will, I am certain, agree with me in thinking that it is right it should be shewn to be so.

Such is the nature of the changes which take place. In the application of the plan, however, to the copper-smoke, the difficulties appear to me insurmountable.

In the first place, as I have repeatedly observed, it is absolutely and essentially necessary, that the draught of the furnaces be maintained undiminished;—but how can this be done, when the smoke has to pass through a compact and large body of charcoal, inclosed in air-tight vessels? Supposing the charcoal to be all large, and that the pieces could be so placed as to admit with facility the passage of as much smoke through the interstices, and with the same rapidity, as through a flue of the usual dimensions, there would be no difficulty on this point. But, if the charcoal happened to be small, the furnace-men inattentive, or more fire on the grate than usual;—what would become of the operations in the Works? In fact, in the experiments I have made with charcoal, I have experienced nearly the same obstructions, and obtained nearly the same results, as with coal and other carbonaceous substances.

In the second place, the sulphurous acid gas will not of itself support combustion;—how then is the charcoal to be kept in that state of perfect ignition which is essential for the success of the process? It can only be done by an external fire; and what an enormous consumption of fuel would this entail? what difficulties in constructing an apparatus for the purpose, in finding the materials of which it is to be formed, in making it air-tight, and in keeping it so? These must all be overcome, before the principle can be at all available; and, to me, offer insuperable objections to the plan. In the experiments which I made, it is true, the combustion of the charcoal was supported, apparently, by the smoke itself; but, in reality, this could only be by means of the oxygen gas that passed uncombined through the grates of the furnaces, or was admitted into the flue through the leakages. This was found, by experiment, to be about nine per cent. even when there was a pressure outwards; and this oxygen, though in my experiment it preserved the

fire, and appeared to obviate one difficulty, would greatly increase the consumption of the charcoal, and, until disposed of, would entirely prevent the decomposition of the sulphuric and sulphurous acids; as, whilst oxygen was present, no reduction of the sulphur could take place.

A farther objection to the decomposition of the smoke by charcoal, is the difficulty of bringing a solid body into contact with a gaseous one; and this is so great, that I think it may even be presumed, that any decomposition that did take place in the experiments with that substance, was owing, more to the action of the carburetted hydrogen, evolved from the charcoal, than from its carbonaceous contents.

But, supposing these difficulties could be surmounted, the quantity of charcoal required would be ruinous; and, in fact, puts the plan totally out of the question. It appears, from the calculations of Messrs. Phillips and Faraday,—who are unanimous and decided in their opinion as to the inapplicability of the whole plan,—that the quantity of charcoal required to decompose the sulphurous acid gas formed in our Works alone; supposing, as most favourable to the plan, the whole of the sulphur contained in the ores to be converted into sulphurous acid, and that no portion of sulphuric acid was formed,—would amount to 45 tons of charcoal weekly. And, in addition to this, they observed, that when carbonic acid gas is passed over ignited charcoal, it is converted into oxide of carbon; so that, as very little soot is deposited in the flues, and very little carbonaceous smoke is formed and sent into the air; it may be concluded that almost the whole of the fuel used is converted into carbonic acid; and, in this view of the subject, it appears, that as much charcoal must be used to reduce the carbonic acid formed during, and by the combustion of the coal on the grate, as that carbonic acid contains of carbon; or, in other words, that in addition to the 45 tons of charcoal employed to decompose the sulphurous acid, *as much more must be used, as is equal to that of the fuel employed in the*

processes in which sulphur is liberated, in the state of sulphurous acid.

From whence, then, is all the charcoal to be procured? It is probably no exaggeration to say, that all the available woods in Glamorganshire would not furnish a year's consumption for the copper-works in that county. But if it were possible to provide charcoal, how is the expense to be defrayed?* It has been said that the sulphur obtained would in part, if not altogether, do this. But even here a difficulty occurs, and that is, to effect the condensation of the sulphur evolved. How is this to be accomplished, three material points being attended to?—the exclusion of all atmospheric air; the reduction of the temperature of the flue; and the preservation of the draught of the furnaces. In the various experiments I have made, I have not been able to obtain a particle of sulphur (except in one instance, when there was a slight deposit on the glass placed over the flue), although I used every possible precaution to exclude atmospheric air, and to reduce the temperature of the flue beyond the charcoal fire, by covering it with clay, and keeping a stream of running water playing on it. But were it even possible, by this means, to obtain sulphur, it would necessarily be very impure, unless the other substances contained in the smoke were previously got rid of by repeated washings; in which case, the consumption of charcoal would be greatly increased, by the considerable addition of common air admitted through the leakages into the chambers and flue; and as the volume of smoke, or rather gaseous result, increased, the de-oxidizing mass of charcoal must increase also, to allow of air-way through it; and, consequently, the difficulty attending the construction of air-tight chambers, of enormous external fires, of

* The present price of charcoal, delivered at the Works, is from thirty-eight to forty shillings per dozen bags; and as a bag weighs about 170 lb. the cost of a ton is from fifty shillings to two guineas and a half. What it would be, six months after the de-oxidizing system had commenced, I shall not presume to say.

condensing agencies, &c. would be also proportionally increased. And after all, supposing all these difficulties overcome, (which I hold to be quite impossible,) and all the copper-smelters to become also manufacturers of sulphur, what is to become of the product? Its quantity alone would render it of little or no value, even if it could be obtained in a pure state.

[*To be continued.*]

II.—*Remarks, in consequence of an anonymous Attack upon our Article "On soldering Sheet-Iron with Cast-Iron." By the* EDITOR.

IN our last Volume (p. 110), we gave an account of thin sheet-iron cylindrical tubes, being soldered together at their edges with cast-iron filings, borax deprived of its water of crystallization, and sal-ammoniac. Not having had any opportunity of seeing the process performed, we endeavoured to describe a method which, we were certain, would have the desired effect. It now appears, however, from the *remarks of an anonymous journalist*, (who has had the opportunity which we wanted,) that the method there indicated is not that actually employed: and he describes, as well as he is able, that which he saw performed; and from which, it clearly appears to us, that *it is a real soldering process; and not*, as he says, *a mere "welding together of the edges of thin plate-iron."* We shall give some extracts from his remarks, for the information of our readers.

He states, that "the operation of *welding together* the edges of thin plate-iron, is, we believe, a novel practice in this country, and *one which we should scarcely have credited without ocular proof.* This process is said to have been first practised by a Mr. Pettybone, of Boston, in North America, who may be called the inventor; it is, however, now in very successful operation, at the works of Messrs. Hancorn, Willoughby, and Co., Birmingham, and in some manufactories at Sheffield and its neighbourhood."

He then (after some *impertinent* remarks, which are not worth quoting) proceeds to give an extract from our Article; and adds as follows:

"As the invention may be useful in many situations, we beg leave to submit *the details* of this novel operation of welding the edges of thin plate iron as it was performed under our own observation by an ordinary working smith in the neighbourhood of Birmingham.

"A piece of thin plate iron in its black state was carelessly bent up by the hammer into the form of a cylinder, the edges meeting, (query *overlapping?*) though not with any particular accuracy; a small portion *of a hard shining material*, which looked something like pitch, was then pulverized, in a mortar, and a little of its powder laid upon the joint which was about to be welded. The cylinder was then held by a pair of tongs in the forge fire and made *red hot*, by which the powder became melted, the iron was immediately withdrawn from the fire, and being brought over a cylindrical arm extending from the anvil, so much of the joint was beaten with a hammer, and welded together, as the continuance of the heat would allow. Other small quantities of the powder were from time to time laid upon the unjoined edges of the plate iron, which on being again introduced into the forge fire, and raised to a *red heat*, was expertly withdrawn from the fire, and beaten by a hammer until the edges of the plate iron were perfectly welded together and the cylinder complete.

"This operation appears to be very easily effected by a dexterous workman, and though the edges of iron plates, *as thin as the seventieth part of an inch*, have been (as we understand) frequently welded together; yet it does not appear that more than one in fifty upon an average, have been burnt and spoiled in the operation. We have for our own satisfaction preserved the identical cylinder welded under our own observation, in which the union of the edges appears to be extremely perfect, and the metal though in so thin a body is in no way injured by the fire;

the only part of the process which is involved in secrecy, is the material which is employed as a flux, this is known only to a few: it is not, however, a metal by which the parts might be soldered together, but has merely the effect of removing the black scales and oxidation on the surface of the iron plates, and also of excluding the air while the edges of the metal are (at a temperature very much below its melting point,) by the hammer brought into perfect cohesion."

We must own, this is a most curious way of giving "*the details*," and overcoming the difficulties attending the elucidation of this *secret process* for joining the edges of thin sheet-iron tubes or cylinders; and we sincerely wish the writer had taken a little more pains in endeavouring to *ascertain the nature of the secret material, which, he says, is employed as a flux only; but which, we firmly believe, will prove to be both a flux and a solder, composed of cast-iron filings, fused with glass of borax.*

Should this be the case, then the wonder ceases, and the information obtained by our friend, from Mr. Jacob Perkins,—that the union was effected, as we have already stated, by *filings* of *soft* cast-iron, applied by means of borax, *deprived of its water of crystallization*, and sal-ammoniac,—will turn out to be correct; and that the operation is really one of *soldering*, and not *welding* the edges of sheet-iron together: and, indeed, in the description of the process, as performed in the presence of the reporter, he no where speaks of a *welding heat*. It is true, that he mentions the heating the cylinder *red-hot*, and again to a *red heat*; but this, it is well known, is not, by any means, sufficient for *welding* sheet-iron, which requires a *white heat*.

It should be observed, that the Americans at Birmingham, who soldered the sheet-iron cylinders shewn to us, were concerned in making nails, by machinery invented by Mr. Jacob Perkins, from whom our friend had his information on the method of soldering the edges of thin sheet-iron together; and this was sufficient to induce us to place implicit reliance on its accuracy. Not, however,

as we before said, having had the opportunity of seeing the process performed, we endeavoured to describe it in a way, which we knew would produce the desired effect. Should, however, *the previous fusion of the borax with the cast-iron filings, at a gentle heat, to avoid melting the cast-iron, into the form of a hard shining material, and then using it in the state of a dry powder, both as a flux and a solder,* be attended with advantages over that method; we shall be glad, for the public benefit, that we have been led into this discussion, and the farther explanation of this useful process.

III.—*On Iron and Steel. By the* Editor.

[Continued from Vol. II. p. 277.]

ON WELDING CAST-STEEL AND CAST-IRON.

We here furnish our readers with extracts from an article, published by us in the "Annals of Philosophy" in March, 1818; but which, we think, ought also to accompany the other articles "On Iron and Steel," contained in this work.

We first noticed the difficulty of welding the higher converted cast-steel to iron; and stated, that the public were indebted to Sir Thomas Frankland for the first accurate information on the means of performing it: namely, by heating the iron to a welding heat, and the steel as hot as it would safely bear, when, by dexterous management, the union might be effected, without much injury to the steel.

We then stated our surprise at the information we had recently obtained from the late scientific Mr. Samuel Varley, of a smith in the neighbourhood of Chevening, in Kent, being in the frequent habit of welding pieces of cast-steel together, without injury to them; and in this way *could unite two worn out mill-wright's picks into a new and serviceable one;* and that in order to prove the value of his process, he, Mr. Varley, had broken a bar of superior cast-steel into two parts, and caused the smith to unite them again; and which was done, without injuring the quality of the steel in the least degree.

We next added, that having mentioned the latter process to many persons of information,—to most of whom it was a new fact,—we learned from that scientific mechanic Mr. Charles Sylvester, late of Derby, that he had frequently performed it, *and even with greater ease than he could weld iron, as the welding heat of cast-steel is considerably below that of iron;* and that the chief cause of failure in attempting to do it, was, by persons heating it too much, conceiving that it required to be treated like iron, whereby it had been totally destroyed. That it, however, required a different flux from iron, to prevent its oxidation, to which it is extremely liable; and that the welding sand used for iron, was totally unfit for this purpose. He preferred *finely-powdered glass of borax,* or the greenish-black glass of which common bottles are made, which consists of sand and alkali only, having no lead in it, as in flint glass; and he thought that if it were to be fused with an additional portion of alkali, it would be still better.

We also found, that Mr. George Scott, another ingenious mechanic, had employed the process for three years past; and a few days since, *had thus united four cylindrical rods of cast-steel, each four feet long, and about half an inch in diameter, after being truly turned in the lathe, into one of sixteen feet long, in order to form a triblet for drawing lead pipes upon.*

But, what was yet more singular, in the course of our inquiry, we were informed by Mr. Jonathan Dickson, engineer, of Holland Street, Blackfriars, that *two bars of cast-iron might thus be united,* their ends being previously enclosed in a wrought-iron tube, and heated to a proper degree; the tube serving as a mould, to prevent the fused cast-iron from falling asunder during the operation.

We then mentioned, that in order to promote the success of welding cast-steel, we would recommend the employment of a charcoal fire; and that the pieces, after being formed of a proper shape for uniting, should have the surfaces intended to be joined, filed bright, be coated with

borax, and be bound together firmly by bands, hoops, &c. previously to their being put into the fire: or else, that as soon as they were heated sufficiently to fuse the glass of borax or bottle-glass, they might be coated therewith on their outsides, either by dipping them into those substances powdered, or by sprinkling them over with them; and that no more heat than was absolutely necessary to effect the union should be employed, and thus the properties of the steel would be as little injured as possible by the process.

We concluded, by adding, that it was no unfrequent practice amongst country smiths, *to unite cast-iron to wrought-iron*, in place of using steel, and particularly for the coulters and shares of ploughs, on account of its cheapness; and that for such coarse purposes, it might answer tolerably well. We were not, however, then aware, *how valuable cast-iron would prove, as a solder for thin sheet-iron.* And we think, that borax made into a powder, in Gellert's manner, (as described in the article in our last volume, "On Soldering Sheet-Iron with Cast-Iron,") would be preferable to making it into glass of borax, on account of the difficulty of powdering the latter substance.

IV.—*On the Preparation of Enamel Colours, and Fluxes; and the Vehicles for laying them on with. By Mr.* Robert Wynn.*

Sir, *Wellington Place, Vauxhall, March* 11, 1817.

The liberality of the Society, in encouraging and rewarding communications in every useful art, induces me to offer to their notice a concise and complete method of composing enamel colours, &c.

Painting in enamel colours has always been considered very interesting, and one of the most costly productions of art, in every country where practised; but the real pre-

* From Vol. XXXV. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted the sum of Twenty Guineas to Mr. Wynn, for this Communication.

paration of the colours has always been confined to the knowledge of a few persons, who have made a mystery of it; and whatever has been yet published on the subject, appears to be chiefly the compilation of writers unskilled in the profession. Many artists of superior talents, in different parts of this country, could practise the art, but for the difficulty of procuring a good set of colours: indeed, it is extraordinary with what suspicious secrecy the art of making enamel colours has hitherto been conducted. I have been acquainted with several of the best manufacturers, whose colours were used by the most eminent painters, on the finest and most elaborate works of the time; but who have died without ever benefiting their country by publishing their acquirements, or leaving any documents behind them. It is not indeed impossible, that the present improved state of knowledge in the art, might be entirely lost, were not some experienced professional person to seek an opportunity of making it public. With these motives, I take the liberty to offer the accompanying treatise, which consists of the most valuable selections from the experience and labours of above twenty years.

I am, Sir, your most obedient Servant,

A. AIKIN, *Esq. Sec. &c. &c.* ROBERT WYNN.

Introductory Remarks.

The different qualities, or degrees of purity in the ingredients, as usually met with; will, while following the same prescriptions, nevertheless produce some slight variations in their effects: but the best enamel colours may always be obtained with certainty, by careful attention to the following directions.

When metals are dissolved, their solutions should always be perfectly saturated. In making the fluxes, they should be sufficiently melted in the crucibles, to flow liquid, and pour out easily.

The various qualities of the materials, or surfaces, on which painting in enamel is performed, require the colours

to be adapted to the degrees of heat they will bear, or require, when burnt; and it is the general practice of the best painters in enamel, to use for the first painting and burning, colours considerably harder than those used in the second; the latter being fine soft enamels, in order to finish the work, and give it a beautiful polish. It cannot but be obvious to every person who uses enamel colours, that the hardening them, if necessary, will be effected by adding more of the colouring matters, or lessening the quantity of flux; and, if required to be more soft, or to shine more when burnt, to add a little more flux; and this is best done by a very soft flux, generally used for this purpose, such as No. 8: but when particular directions are necessary, they will be mentioned in the receipts for making the colours. It will be better to make a few ounces, at least, of each colour at a time; and they must all be ground as soon as made, in water, with a glass muller, on a piece of plate glass; then be dried before the fire, scraped off in powder, and kept in bottles for use.

When used for painting with, they are ground in spirits of turpentine, and thickened with thick oil of turpentine; this quality, the fluid oil of turpentine acquires in three or four years.*

PREPARATION OF THE MATERIALS.

Flint Powder.

Take pieces of flint, which have been burnt white at the chalk lime-burners (they may be had at the lime-burners' at Vauxhall); make them clean with hot water and a brush; then throw them, when heated red-hot, into cold water: after having thus treated them two or three times, pulverize them in a biscuit-ware mortar, with a pestle of the

* In the China manufactories, this thick oil of turpentine is obtained for painting with, by placing a number of china saucers, one within another—say five or six; and putting fluid oil of turpentine into the upper one from time to time, it gradually rises, and flows over into the next below, and so on, till it finally becomes sufficiently thick, from evaporation, for use.—EDITOR.

same material, (which will be easily effected,) and then grind them in water, on plate glass.

Where no opportunity occurs of procuring burnt flints from the lime-burners, the common black flints, broken into pieces, made hot in boiling water (to prevent their flying in the crucible), and treated in the same way, will produce a fine white powder.

Red Sulphate of Iron.

Sulphate of iron, otherwise called Green Vitriol, is to be pounded, and placed in an earthenware muffle, till the moisture is evaporated, and a grey powder left; which, put into a crucible placed in a charcoal fire, and stir with a piece of steel bar, till it is of a fine red colour; then, let it fall out of the crucible into a pan of cold water, placed under a chimney, in order to avoid the disagreeable fumes that arise; when settled at the bottom of the pan, wash it in several hot waters, and then dry it for use. The more it is burnt, the darker is the red.

Brown Sulphate of Iron.

Take sulphate of iron, in lumps, and calcine it, in a red charcoal heat, till it becomes of a deep brown colour; let it cool in the crucible, and afterwards wash it repeatedly in hot water.

Black Oxide of Copper.

Take copper, and dissolve it in aqua-fortis, till the acid refuses to take up any more metal; then dilute the solution with water, and add to it some sub-carbonate of potash dissolved in water; a green precipitate will fall to the bottom of the vessel, which must be washed in several hot waters; when settled, pour off the superfluous water, and place the green deposit on a piece of blotting-paper, supported upon a piece of coarse open canvas, tied over the mouth of a large earthen pan; after the precipitate has been thus drained, it should be taken off the canvas, and made perfectly dry, by placing the paper on powdered

chalk, laid in a drawer, and put before the fire. When dry, calcine it in a crucible, placed in a charcoal fire, and throw it, red-hot, into cold water; then rinse it in boiling water, and dry it at the bottom of a basin, before a fire: this is a beautiful black oxide of copper.

Green Oxide of Copper.

Take a saturated solution of copper in aqua-fortis, and precipitate it with sub-carbonate of potash; then wash it several times in boiling water, filtre, and dry it.

White Oxide of Tin.

Into a small wooden box, with a sliding cover, chalked all over inside, pour melted tin from a ladle, close and shake the box, till the tin becomes finely granulated; then wash and dry it, and put it into a clean Florence oil-flask, and pour over it strong nitrous acid, which rapidly converts it into a white powder. When a sufficient quantity of this is obtained, it should be well washed in several boiling waters, be poured out into a basin, and dried before the fire;—it is then a very white oxide of tin.

Black Oxide of Cobalt.

Take good metallic cobalt,* and dissolve it to saturation in nitric acid diluted with a little water, contained in a flask, placed in a sand-bath; then pour the solution into a large basin, and having added a quantity of water to it, pour into it a solution of sub-carbonate of soda, as long as any precipitate falls down: when settled, pour off the water, wash the powder in several hot waters, filtre it, and dry it. When dry, mix it in a biscuit-ware mortar, with a pestle of the same, with three times its weight of dry nitre; put the mixture into a warm crucible, and drop into it an ignited piece of charcoal: some slight explosions will then take place; and when these have ceased, make the calx red-hot: this, after being washed and dried, is the best oxide of

* In the choice of cobalt, that which, when dissolved in nitric acid, gives the purest and deepest red solution, generally makes the finest colours.

cobalt for enamel; and is capable of forming various colours, single and compound.

Fluxes.

In forming these, take great care to mix all the ingredients accurately, in a biscuit-ware mortar, with a pestle of the same material, and to powder them as finely as possible. Let the crucibles be made warm, before the fluxes are put into them (by placing them on the fire, with the open end downwards), which will prevent their breaking in the fire.

The best furnace for making fluxes, or for any other purpose that requires great or continued heat, is a common German stove, about 18 or 20 inches diameter, lined all round, from the grate to the top, (except the aperture at the door in front, for the occasional introduction of a muffle,) with one row of fire-bricks, set with loam; the iron-pipe of the chimney projects from the back part, near the top. The top or cover of the furnace must be loose, like a lid, and be removeable by handles; in the centre of it a circular hole must be made, which must also be fitted with a cover, and through which hole, the cover of the crucible may be lifted off, and its contents stirred up with a bar of steel. A small piece of fire-brick must be placed on the grate, for the crucibles to stand on; and the fuel should be either charcoal and coke mixed, or charcoal alone.

Flux, No. 1.	Red lead . . .	8 parts, by weight,
	Calcined borax*.	1½ parts,
	Flint powder .	2 parts,
	Flint glass . .	6 parts.
Flux, No. 2.	Flint glass . .	10 parts,
	White arsenic .	1 part,
	Nitre	1 part.
Flux, No. 3.	Red lead . . .	1 part,
	Flint glass . .	3 parts.

* Borax, calcined to a dry white powder in a crucible, only a third part of which should be filled at once, on account of the borax swelling up so much, as it gets hot.

Flux, No. 4.	Red lead . . .	9½ parts,
	Borax, not calcined,	5½ parts,
	Flint glass . .	8 parts.
Flux, No. 5.	Flint glass . .	6 parts,
	Flux, No. 2. . . .	4 parts,
	Red lead . . .	8 parts.
Flux, No. 6.	Flux, No. 2. . .	10 parts,
	Red lead . . .	4 parts,
	Flint powder . .	1½ parts.
Flux, No. 7.	Flux, No. 4. . .	6 parts,
	Colcothar . . .	1 part.
Flux, No. 8.	Red lead . . .	6 parts,
	Borax, not calcined	4 parts,
	Flint powder . .	2 parts.

After the fluxes have been melted, they should either be poured upon a flag-stone, wetted with a sponge, or into a large pan of clean water; they should then be dried and finely powdered in a biscuit-ware mortar, for use.

Yellow Enamels.

Red lead	8 parts,
Oxide of antimony . .	1 part,
White oxide of tin . .	1 part.

Mix the ingredients well in a biscuit-ware mortar; and having put them on a piece of Dutch-tile in the muffle, make it gradually red-hot, and suffer it to cool.

Take of this mixture .	1 part,
Of Flux, No. 4. . . .	1½ parts.

Grind them in water, for use.

By varying the proportions of red-lead and of antimony, different shades of colour may be obtained.

Another Yellow Enamel.

Take three parts, by weight, of sheet-lead, and one part of block-tin; melt them together in a ladle or a flat shovel, and skim off the top as fast as it oxidates. When a sufficient quantity is thus obtained, place it in the muffle, in a gentle

reverberating heat, to calcine any remaining particles of metal *:

Of which, take . . .	7½ parts,
Oxide of antimony . .	1 part,
Litharge	1 part.

Mix these well together, and give them a red heat in a muffle, sufficient to bind them together, but not to melt them. Use the same flux as for the other yellow.

Orange Enamel.

Take red lead . . .	12 parts,
Red sulphate of iron .	1 part,
Oxide of antimony . .	4 parts,
Flint powder . . .	3 parts;

well mixed together in the mortar, and heated, so as to adhere together, but avoid melting.

Take of the above . .	1 part,
Flux, No. 7.	2½ parts.

Grind for use.

Dark Red Enamel.

Brown sulphate of iron	1 part,
Flux, No. 7.	2½ parts.

Grind for use.

Light Red Enamel.

Red sulphate of iron .	1 part,
Flux, No. 1.	3 parts,
White lead	1½ parts.

Grind for use.

Red Brown Enamel.

Brown sulphate of iron	1 part,
Flux, No. 1.	3 parts.

Grind for use.

* This, after being finely ground, forms the ***putty***, so much used in polishing steel, &c.—EDITOR.

Vandyke Brown Enamel.

Flux, No. 4, ... 3 parts,
Iron filings . . . . . 1 part,

Melted together in a crucible, and drawn out with tongs;* with so much metal it will not pour out freely.

Take of the above . . 5 parts,
Black oxide of cobalt . 1 part.

Grind for use.

Another Brown Enamel.

Manganese . . . . $2\frac{1}{2}$ parts,
Red lead . . . . . $8\frac{1}{2}$ parts,
Flint powder . . . 4 parts,

Heated, so as to stick together:

Of this mixture take . $1\frac{1}{2}$ parts,
Flux, No. 4, ... 1 part,
Iron filings . . . . $1\frac{1}{2}$ parts.

Grind for use.

Black Enamel for Painting, and mixing with other Colours.

Umber, broken into small pieces and calcined in a yellow heat in a crucible, till quite black, then washed in boiling water and dried:

Of this take . . . . 10 parts,
Black oxide of cobalt. 10 parts,
Blue flint glass . . $10\frac{1}{2}$ parts,
Borax, uncalcined, . $7\frac{1}{2}$ parts,
Red lead . . . . 12 parts;

Heat these well together:

Take of the above . 2 parts,
Flux, No. 4, ... 1 part.

Grind in water for use.

Blacks are compounded in other proportions of these

* In this, and in other cases where a muffle is not in readiness, an earthen crucible, washed over with flint powder inside, or with dry flint powder rubbed inside of it, one-eighth of an inch in thickness, may be used; and the materials, when partially melted, so as to bind together, may be then entirely taken out without loss.

ingredients, and manganese is sometimes substituted in the place of umber.

Another Black Enamel.

Umber, calcined black,	1 part,
Black oxide of cobalt .	1½ parts,
Black oxide of copper .	½ a part,
Flux, No. 4, ...	3 parts.

Grind these in water, and when dried, place them on a piece of Dutch tile (previously washed over with flint powder ground in water), in a muffle, in a charcoal fire, and heat them so as to bind together; then add half a part of Flux, No. 4.

These blacks, if too soft, are hardened by adding a little black oxide of cobalt.

Black Enamel for Shading, and Drawing under the Greens.

Manganese	5 parts,
Royal smalt	1 part,

Ground fine in water, and heated to a high degree in a muffle.

Beautiful Black Enamel for Solid Grounds or Inlaying, but does not mix generally.

Black oxide of copper .	1 part,
Flux, No. 4, ...	2 parts.

Grind in water for use.

A Frit for Transparent Green Enamels.

Flint powder	3 parts,
Flux, No. 2, ...	3 parts,
Green pot-metal glass	1½ parts,
Red lead	7½ parts,
Borax, uncalcined, . .	2½ parts,
Green oxide of copper .	1¼ parts.

Melt them in a crucible, pour out the mass, and powder it in an earthenware mortar.

Green Enamel.

Take of the green frit . 3 parts,
Of yellow enamel . . $1\frac{1}{2}$ parts;
If too soft, add Naples yellow.
Grind in water for use.

Another Green Enamel.

Green frit . . . . . 5 parts,
Flux, No. 2, ... $\frac{1}{2}$ a part,
Flux, No. 6, ... $2\frac{1}{2}$ parts.
Grind in water for use.

Greens, for painting in enamel, are formed of various shades by mixing blue and yellow, blue and orange, &c. in different proportions.

Blue Enamel.

Black oxide of cobalt . 4 parts,
Flint powder . . . . 9 parts,
Nitre . . . . . 13 parts.

Mix the ingredients well in an earthenware mortar, and heat them in a crucible, in a strong fire of coke and charcoal, till perfectly melted*; then powder the mass, wash it in cold water, and dry it:

Of this take . . . . 1 part,
Flux, No. 5, ... 1 part.
Grind in water for use.

Another Blue Enamel.

Take black oxide of cobalt 1 part,
Borax, uncalcined, . . . 1 part:
Melt them together:
Of this mixture take . . 2 parts,
Blue pot-metal glass . . 10 parts,
Red lead . . . . . $\frac{1}{2}$ a part.

* If these preparations are not sufficiently fluid in the melted state to pour out of the crucible, the colour will adhere to a piece of steel bar, when it is warm, and may be drawn out; and sometimes the blues are made in crucibles lined with flint powder, as before mentioned.

Melt them in a very strong fire. If either blue is too soft, add a little royal smalt; if too hard, a little flux, made of

Blue glass . . . . . 2 parts,
Borax . . . . . 1 part.

Purple Enamel.

Take fine gold from the refiners, and dissolve it to saturation in an aqua-regia made as follows:

Of the strongest nitric acid, 1 part, by measure,
Muriatic acid . . . . 3 parts,
Distilled water . . . . 3 parts.

Make the solution in a clean Florence oil-flask, placed on sand near the fire. Pour melted tin into cold water to granulate it, and dissolve it to saturation in diluted aqua-regia 4 parts. Place the tin and the acid in a large basin, covered with an earthen plate, in a temperate heat: when the tin is all dissolved, add still more tin, and also strong red fuming nitrous acid $1\frac{1}{2}$ parts; and again dissolve the tin to saturation, covering the basin with the plate, to prevent the fumes from escaping. After standing 24 hours, a little distilled water should be poured into the basin. The solution of tin may then be put into a clean phial, for use, adding to it a few grains of tin; examine it, after four or five days, when the solution, if carefully made, will be of a fine clear dark colour, and fit to make purple with.

Then, of the solution of gold, take sufficient to make distilled water of a faint yellow colour, and drop gradually into it the solution of tin, till the last added drops occasion no turbidness in the liquor, and a most beautiful purple precipitate will immediately be formed, which must be thrown, as it is made, into a large vessel, and two or three pieces of the granulated tin should be put at the bottom of the vessel. The precipitate is then to be washed in several hot waters, filtered on the blotting paper and canvass, and, while in a moist state, is to be mixed with the flux, No. 4, finely powdered.

The proportion of the flux to the purple precipitate is

always various, and is judged of by the mass being of a good rich dark colour, as the ingredients are ground together on the plate-glass. Care must be taken to grind this colour before it gets dry.

Twenty-four grains of gold made into a precipitate in this manner, will take two ounces of flux; and this may be a rule to the inexperienced practitioner.

Rose-coloured Enamel.

To a saturated solution of gold in aqua-regia, (containing twenty-four grains of gold,) diluted with 100 times its bulk of warm distilled water, having 20 grains of alum* dissolved in it; add caustic ammonia, drop by drop, as long as any precipitate is thrown down, which precipitate wash in several hot waters.

To 24 grains of gold, precipitated in this manner, add

Flux, No. 4, . . 2 ounces.
Flux, No. 3, . . 2 ounces.

Mix them together wet, and grind them on a plate-glass, adding, by a leaf at a time, 16 leaves of leaf-silver: when the whole is ground fine, let it be dried on the glass, scraped off, and put into a bottle for use.

This rose-colour grinds of a grey or slate colour; but, after being ground, if it be placed in a muffle, and exposed to a gentle heat, it will turn to a red colour: it is fit for use in either state.

If too yellow, add a little purple; and if too purple, add more leaf-silver.

Another Rose-coloured Enamel.

Take purple, made as before directed, 1 ounce.
Flux, No. 3, ... 4 ounces.
Muriate of silver . . . . . 10 grains.

The latter ingredient is prepared, by dissolving silver in aqua-fortis, and precipitating it with common salt.

* The rose-colour is sometimes made without any alum.

Grind in water for use. If too purple, add more muriate of silver.

Opaque White Enamels.

Hartshorn shavings, burnt in a crucible, in a charcoal fire, till perfectly white, ... 1 part,
Flux, No. 1, . . . 1 part.
Grind in water for use.
Venetian white cake enamel, 1 part,
Flux, No. 8, ... 1 part.

Grind in water; then heat them together in a muffle.

Flux, No. 2, powdered and washed, then dried and heated in a muffle.

It would not be difficult to exhibit a multitude of specimens of different tints, and to fill a volume with descriptions of them, merely by combining these original enamel colours in various proportions: this, however, may safely be left to the taste and experience of the artist. My object has been, to avoid every thing superfluous; and, at the same time, to explain the processes adapted to immediate practice, in terms not liable to be mistaken.

V.—*On Staining and Gilding Glass. By Mr.* ROBT. WYNN.*

IN *coloured glass*, the whole body of the material is tinged, by means of some colouring ingredient being uniformly diffused through, or dissolved in, the substance of the glass.

In *enamelling*, the colours, being ground up with an easily vitrifiable flux, are laid upon the surfaces of metal, porcelain, or glass; and are then exposed to such a degree of heat, as shall just melt the enamel, and fix it on the surface of the substance to which it has been applied.

In *staining glass*, the colouring ingredients are mixed with water, or some other fluid vehicle, by means of which,

* From Vol. XXXV. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

they are spread over the surface of a plate of glass; and, when dry, are exposed to such a degree of heat, as, by experience, has been found to be sufficient. The unabsorbed colours are then rubbed off from the surface of the glass, to which they do not adhere; and those parts of the plate which had been thus covered, are found to have acquired a permanent and transparent tinge or *stain;* doubtless, from some particles of the colour having been absorbed, and fixed in the pores of the glass.

In all the compositions for staining glass, silver, in some form or other, enters as an essential ingredient. I shall therefore begin by describing the different preparations of silver that I make use of.

No. 1. *Nitrate of Silver.*

Take two or three ounces of pure nitric acid, dilute it with three times its bulk of distilled water; put it into a Florence flask, or any other convenient glass vessel, and add to it refined silver, by small pieces at a time, till the acid, though kept at a warm temperature, ceases to dissolve any more. After standing quiet for some hours, pour off the clear liquor, into a clean phial with a ground stopper, for use.

No. 2. *Muriate of Silver, or Lunar Cornea.*

Dissolve common salt in water, and add nitrate of silver, drop by drop, till it ceases to occasion any precipitate: there will thus be obtained a heavy white curd-like substance, which must be well washed in hot water, and dried: by exposure to light, it becomes of a dull purple colour.

No. 3. *Carbonate of Silver.*

Dissolve sub-carbonate of soda in water, and add nitrate of silver, as above described. The white precipitate thus obtained, when washed and dried, is ready for use.

No. 4. *Another Carbonate of Silver.*

Dissolve sub-carbonate of potash in water, add nitrate of silver, and proceed precisely as directed for No. 3.

No. 5. *Phosphate of Silver.*

Dissolve phosphate of soda in water, add nitrate of silver, and proceed as already mentioned. The precipitate, thus obtained, is of a yellow colour.

No. 6. *Sulphuret of Silver.*

Take any quantity of pure silver, rolled out into thin plates, and put it into a crucible, together with some sulphur. When the crucible has been a short time on the fire, the sulphur will melt, and will then gradually burn away with a blue flame. When the flame has ceased, add some more sulphur, and proceed as before; then take the silver out, and heat it red in a muffle; it will now be white and very brittle, and after having been reduced to powder in a mortar, is fit for use.

No. 7. *Silver precipitated by Tin.*

Take any quantity of a dilute solution of nitrate of silver, No. 1, and put into it a bar of metallic tin; warm the solution a little, and the silver will be precipitated, in the form of metallic leaves, upon the surface of the tin. Scrape it off, wash it in warm water, dry it, and grind it in a mortar, for use.

No. 8. *Silver precipitated by Copper.*

Take any quantity of a dilute solution of nitrate of silver, and put into it a piece of copper-plate: then proceed precisely as in No. 7.

The foregoing preparations of silver, mixed with other ingredients, in the proportions about to be described, compose all the varieties of pigments which are requisite for staining glass.

Yellow Stains for Glass.

Take silver, No. 3, . 1 part,
Yellow lake, . . . 1 part.

Mix the ingredients, and grind them well with oil of turpentine mixed with the thick oil of turpentine: * lay the composition on the glass thin.

* For the preparation of this, see the foregoing Article.—EDITOR.

Take silver, No. 2, ... 1 part,
Alumine precipitated from a solution of alum, by subcarbonate of soda, ... 3 parts,
Oxalate of iron, prepared by precipitating a clear solution of sulphate of iron, by oxalate of potash, 3 parts,
Oxide of zinc . . . . . 2 parts.

Let the silver be ground first in water with the oxide of zinc, and then with the other ingredients. This is intended for floating on the glass thick.

Take silver, No. 4, ... 1 part,
Yellow lake . . . . . 1 part.

Grind them in spirit of turpentine, and the thick oil of turpentine; and lay the mixture on the glass very thin.

Take silver, No. 5, ... 1 part,
Yellow lake . . . . . 1 part,
Alumine . . . . . ½ a part.

Grind them in spirit of turpentine, and the thick oil of turpentine; and lay the mixture on the glass thin.

Orange Stains for Glass.

Take silver, No. 7, ... 1 part,
Venetian red and yellow ochre, equal parts, washed in water, and calcined red, ... 2 parts.

Grind the ingredients in spirit of turpentine, with thick oil of turpentine, and lay the mixture on the glass thin.

Take silver, No. 8, ... 1 part,
Venetian red and yellow ochre . . . 1 part.

Grind in spirit of turpentine and oil, &c. as the foregoing.

If entire panes of glass are to be stained orange, the proportion of ochre may be greatly increased, and the ingredients should be ground in water. The depth of the tinge depends, in some measure, on the heat of the furnace, and on the time that the glass is exposed to it, which, though easily learned by experience, cannot be made the object of precise rules.

Red Stains for Glass.

Take silver, No. 6, ... 1 part,

Brown oxide of iron, prepared by heating scales of iron, then quenching them in water, reducing them to a fine powder, and lastly calcining the powder in a muffle, ... 1 part.

Grind the ingredients with turpentine and oil, and lay the mixture on the glass thick.

Take of antimonial silver, prepared by melting together, one part of silver and two parts of crude antimony, and pulverizing the mass, ... 1 part,
Colcothar . . . . . 1 part.

Grind the ingredients in turpentine and oil, and lay the mixture on the glass thick.

Take antimonial silver, prepared as above, . . 1 part,
Venetian red and yellow ochre, of each, . . . 1 part.

Grind, &c. as before mentioned.

When whole panes of glass are to be tinged, the proportions of ochre or of colcothar may be much increased, and the ingredients should then be ground in water.

Of laying the Colours on the Glass.

The method practised by most stainers of glass, is, to draw the outline in Indian ink or in a brown colour, ground with turpentine and oil, and then to float on the staining colour thick, having previously ground it with water. But in this way of proceeding, it is very subject either to flow over or to come short of the outline, and thus render the skill of the draughtsman of little avail.

My method is to draw the pattern in Indian ink, and, having ground the staining colour as fine as possible, in spirit of turpentine, brought to a proper consistence with thick oil of turpentine; to add a little oil of spike lavender, and to cover the outline entirely with this composition.

When it has become dry, I work out the colour, with the point of a stick and a knife, from those parts that are not intended to be stained; and am thus enabled to execute the most delicate ornaments, and most intricate designs, with great exactness and precision.

If the staining colour is required to be laid on so thick

that the outline would not be visible through it, let the colour be first laid on as smoothly as possible, and, when it has become dry, draw the outline upon it with vermilion water-colour, and work out the design as before.

Besides the precision acquired by the above method, it enables the artist to apply different shades in the same design; whereas the old method of floating only communicates an uniform tint to the whole pattern.

The artist should contrive to charge his furnace with pieces, the colours of which are all ground in the same vehicle; and not mix, in the same burning, some colours ground in turpentine, and others in water. The pieces must also be very carefully dried, and must be placed in the furnace when it is moderately warm.

To Gild Glass.

Take of fine grain gold . . . . . 1 part,
Of pure mercury . . . . . 8 parts.

Warm the mercury in a crucible, and then add the gold, previously making it red-hot. When the gold is perfectly dissolved, pour the mixture into cold water, and wash it well. Then press out the superfluous mercury through linen, or soft leather; and the mercury which runs through, (as it retains some gold,) should be reserved for the next opportunity.

The amalgam which remains in the leather, is to be digested in warm aqua-fortis, which will take up the mercury, but will leave the gold in the form of an extremely fine powder; this powder, when washed and dried, must be rubbed up with one-third its weight of mercury: then mix one grain of this amalgam, with three grains of gold-flux (see flux, No. 4, in the preceding article, "*On the Preparation of Enamel Colours and Fluxes;*") and grind the mixture in spirit of turpentine thickened with thick oil of turpentine, which is to be applied in the usual manner, upon the glass.

This is equally applicable to gilding china, enamel, &c.

VI.—*On Bronze Statues, and Medals; and on Cannon, Bells, &c.*

[Continued from p. 431.]

Medals of Bronze.—We understand, by this title, those medals which are either made of pure copper, or of copper alloyed with various proportions of tin, and sometimes of lead and zinc. These medals, the origin of which we trace back to the times when Greece was in its glory, may still be found in considerable quantities in many of the cabinets of antiquaries. Amongst the most ancient of these, the best preserved are those which are really made of bronze; that is to say, of copper and tin, with a few hundredth parts of other metals; whilst the modern medals, which are struck on memorable occasions,—such as the erection of public monuments, scientific discoveries, and, in general, those remarkable events, the remembrance of which is intended to be perpetuated, (however excellent, for their finished workmanship, the severity of their composition, and the purity of their designs),—are merely pure copper; and, as far as respects their chemical composition, when compared with the antique medals, their inferiority is evident.

The design of the numismatic art is, to preserve the remembrance of particular events, even after the overthrow of empires, to succeeding generations, in those impressions, by means of which, future ages may discover the traces and certain indications of circumstances which have sunk into oblivion. A material sufficiently hard to resist friction, difficultly alterable under various circumstances, and whose value is so small as not to become an object of cupidity, are the requisites most favourable for a long preservation: this material is bronze, properly so called; as the experience of past times and the analyses of the antique bronzes sufficiently demonstrate.

We may well be surprised, after these considerations, that we have, in our days renounced the employment of bronze in the fabrication of medals, and have substituted

copper; a metal from which the impressions are soon effaced by friction; and of which, the coins and medals buried in the earth during the late reigns, are already more altered, than the bronzes of the ancients.

The art of manufacturing medals in bronze, after having been revived by the Paduans, in the sixteenth century, was again lost; and since the establishment of the Mint in France, in the reign of Henry II., refined copper has been exclusively employed in this manufacture. Chemical knowledge was not their guide in the choice of this material; they only endeavoured to imitate the ancients in the finish of their workmanship, and in the colour of the bronze. The malleability of copper facilitating the execution of the medals, caused a preference to be given to this metal; and, for a long time past, custom has sanctioned the use of it.

The chemical analyses of the antique bronzes have demonstrated, that tin is constantly found in them, but not in certain proportions, varying from 5 to 12 hundredths in the weight of the alloy. M.M. Mongez and Dizé have even found still greater variations. (*Annales de Physique.*)

M. Jeuffroy has obtained remarkable results in his experiments on the manufacture of medals in bronze.

M. Darcet, (to whom we are already indebted for some very important observations on this alloy,) induced M. Chaudet to undertake a course of experiments with a view to recover the process of manufacturing medals in bronze. This gentleman, in a memoir published in 1817, (*Annales de Chimie*, Vol. VI.) shewed that he had very nearly attained this object: however, he despaired of being able to manufacture medals of alloy, into the composition of which there entered more than 5 hundredths of tin.

M. de Puymaurin, placed under the most favourable circumstances, made, at the invitation of M.M. Mongez and Darcet, a multiplicity of experiments, directed to the same end; and he appears to have completely solved the problem which was proposed to him. From an interesting

memoir, which he presented to the Academy of Sciences,* I shall extract the chief particulars of this new process.

Experiments on Stamping Medals. Hot.—The considerable relief in some of the antique medals, and the imperfect instruments which were employed by the ancients, have caused it to be thought that their formation had taken place *whilst they were hot, by means of pincers, hammers, and dies of bronze containing from 20 to 25 hundredths of tin;* or rather, that *this operation was performed, after a preparatory moulding, or shaping of the masses, so that the action of the dies merely finished that work which we so much admire.*

The first of these two opinions,—founded on the changes which heat produces on the hardness of metals,—is due to M. Mongez, who discovered it in a very ingenious way: his process is described in the *Dictionnaire Encyclopédique des Antiquités.* M. de Puymaurin has endeavoured to apply it in the large: the limits of this work will not, however, allow us to detail all the experiments which he made on this subject; we shall, therefore, only relate the principal results.

On repeating in various ways the experiments of M. Mongez with the assistance of stamps and presses, he found means to avoid the *frequent annealing:* for this purpose, he instantly plunged the medals into cold water, after being struck; this operation also greatly facilitated the other operations. They thus struck under the stamp, from six to seven pieces per minute, whilst with the press they could only strike two in the same time.†

The most convenient alloy to form the dies of, was found to be, from 74 to 78 of copper, with 26 or 22 hundredths of tin; more tin rendered the alloy too brittle, and a less proportion produced an alloy which was too soft: some of these dies have struck about 800 blanks of 18 lines in

* In the sitting of the 2d of December, 1822.

† By this preparatory process has been made, 9 or 10,000 medals, in copper, of different kinds.

diameter; whilst others, which appeared exactly similar, have only stood the stamping of 30 or 40 blanks.* However, on an average, their duration may perhaps be equal to stamping fron 250 to 300 blanks.

The pieces thus stamped, are easily returned to the machine, and we thus save two or three annealings.

By means of this process, we may expedite the manufacture of medals in copper: but in regard to medals in bronze, many difficulties and inconveniences present themselves:—the exact degree of heat which is best, is very difficult to be ascertained; in fact, the bronze when at a reddish-white or yellowish heat, would crack, and at a low red, the impression would not be sufficiently marked. The alloy must not contain more than 6 hundredths of tin, or we cannot always obtain good results. We however find that this mode, which when applied to copper has completely succeeded, cannot be applied to bronze; at least with the same advantages.†

Manufacture of Medals in Bronze, by Moulding and Casting.—Many antiquaries have thought that this preparatory operation was employed to dispose the masses so, that the dies had only to strike them to finish the medals. This permitted them to use an alloy so little malleable as the antique bronze. It was on this principle that the experiments of M.M. Jeuffroy and Chaudet were made; and

* They remarked still greater differences in the use of steel dies: in fact, dies manufactured with the same care, and by the same workmen, in some instances served for the fabrication of from 14,000 to 22,000 medals; whilst they were sometimes broken, after having struck two or three only. General Levasseur has substituted bronze for steel, with advantage, in the manufacture of nippers to cut off pieces of cast-iron whilst hot.

The superiority of bronze in these operations, permits us to hope, that it may also be found preferable to steel for the purpose of stamping various ornaments of metal, whilst hot.

† The dies of steel used in this process of *stamping hot*, do not last long; because the red-hot metal coming into contact with the steel, soon oxidates it at this high temperature; and thus the impressions on the medals remain indistinct: the projecting parts of the dies also become greatly impaired by being softened.

This evil is completely obviated by applying a little soft soap to the dies before the impression is taken, which causes the red-hot pieces to fly instantly out of them.—Editor.

the results which they obtained, determined M. Puymaurin to complete their labours.

We shall not extend our observations to any great length on the process of moulding and casting of medals in bronze, because it differs very little from casting in general: nevertheless, we must point out the peculiarities attending this subject.*

We must give the least possible thickness to the sand, so that the heat of the bronze may be the more quickly dissipated; the sand or loam should be a little moist, very fine and close internally, and become progressively coarser, or more open, in the exterior layers, in order to facilitate the escape of the gases formed. The ordinary *ponsif*, or facing, may be mixed with very finely powdered slate, or other substances which are susceptible of a minute division, and little liable to be acted upon by heat; but the *ponsif* recommended by M. Chaudet (*bone-ash*) is preferable, as it is formed of a matter (the phosphate and carbonate of lime) which is completely soluble in the hydrochloric (muriatic) acid employed in cleaning bronzes of every description.†

Before pouring the fused metal into the moulds, we apply to their interior surface a coating of lamp-black, by holding them for some minutes over the flame of a lighted torch.

Disposition of the Jet.—The founder of the ornaments, small figures, &c. in *or molu* and bronze, whose work must be finished by the graver or chisel of the repairer, should employ an alloy which is fluid, sufficiently hard not to bend under the chisel, and without being brittle or liable to

* M. Dussausoy has published in the *Annales de Chimie* some very interesting observations on moulding in sand or loam; the advantages derived from this mode of operating are such, that we cannot but regret the impracticability of applying it to the casting of medals.

† According to the observations of M. Chaudet, the use of this *ponsif* prevents the sand from adhering to the cast medals: neither does the *ponsif* itself adhere to them, one stroke of the scratch-brush being sufficient to remove it. It also produces beautifully sharp and clear casts.

The *prepared hartshorn* of the shops is *finely levigated bone-ash*. Possibly this material may answer the purpose.—EDITOR.

crack; its colour must likewise be such, that it may be gilt with the least possible quantity of gold; and that it be susceptible of receiving a beautiful green tint with the composition called *vert antique.* The defects of the casting may easily be repaired with small pieces of metal from the jet; and will disappear under the gilding or colouring, if they are not very considerable.*

The founder in medals has not the same facility; the smallest defects in them, are often irreparable. He must, above all, calculate upon the shrinking of each piece; and his alloy must not only be extremely dense, solid, and durable; but it must possess sufficient fluidity to receive every imprint from the mould; and be of such a malleability, as to be struck by the dies, without injuring them. One part of these conditions depends on the preparation of the moulds.

The jet is generally made with an iron hook or tool, after the moulding is finished; but if we employ this instrument, the sand is liable to be roughened along the course of the jet; and a part of it may be drawn into the mould with the fused metal.

It would be preferable, to sacrifice the first cast, in order to make a model of the jet. We obtain this, by shaping it with great care, in the first mould; we then pour into it, a fused alloy of lead and antimony, and thus procure a model of a jet, sufficiently hard to bear moulding from, and perfectly adapted to the casting of medals. We mould this model of the jet with the patterns; the sand is then smooth, and well closed all over the surface of the mould; and we also avoid the trouble of forming the jet with the iron hook or tool—an operation always long and tedious.

We should, for the purpose of leaving a free passage for the gases to escape, make a separate vent-hole for each medal. In order to effect this, it is sufficient to place short pieces of iron wire, or lead, between the patterns and the

* In almost all the ornamental works in bronze, such as clocks, candelabras, &c. we find defects so repaired.

frames, and to withdraw them when the mould is finished. The size of the jet must be proportional to the size of the moulds; (its thickness does not influence the pressure, which depends entirely on its height above the surface of the medals.)

If the jet be placed too near the medals, and the conduits from it are too large, the shrinkage which it sustains in becoming solid before the medals (and it being retained by the conical neck above, which is formed at the entrance of the moulds or frames), causes an ascending contraction; those parts which are still fluid in the casts, rising, mount into the jet, and the medal will be found to be unequal: this loss of matter is irreparable under the press, the hole remaining visible after its action.

This accident never occurs when the conduits are broad, thin, and distant from the jet, because they quickly become solid; and thus, all communication between the fluid parts of the jet, and those of the medal, is intercepted.

The conduits which proceed from the jet, may either be made to introduce the fused metal into the moulds for the medals at their lower parts, by giving to them the form of a syphon, or directly to their higher parts. In the first case, the metal, when it ascends into the moulds, leaves a free issue for the gases, and disturbs the sand less. This plan might be adopted for bronze casts, if the temperature of the fused metal could be sufficiently elevated: but we have seen that it is attended with inconveniences; and we are obliged, in order to avoid them, to pour the metal in directly at the higher parts; as this permits us to employ a lower temperature, and we obtain medals entirely exempt from holes or blemishes on their surfaces.*

The finish of the moulds is not so necessary here, as it is in the usual moulding of pieces which are not to be submitted to the action of the press. It is requisite, on the contrary, that these masses should be without any marked contours, and the metal be so disposed in them, that there

* See, at the end of this article, an explanation of this phenomenon.

remains, when withdrawn from the mould and after their shrinking, a volume of matter equal to that of the model, as the medal must be of the same dimensions with the model. Now by making a mould of a size exactly equal to the bulk of the model, the piece so cast would be at most but equal to this volume, when in the mould, and at its maximum of dilatation in the solid state; and, consequently, the volume would lessen on cooling; the shrinking which takes place in every part of the masses would render the outlines of the designs of considerably less dimensions; so that, when placed between the dies, and struck by the press, all the contours of the design would be *doubled*.

We perceive then, that, in order to render the cast medals identical with their models, we must exactly allow for the shrinking of which bronze is susceptible; and, as the shrinking is proportional to their volumes, we see that it must vary according to the dimension of the medals, and the quantity of matter in their relief: in this exists the difficulty of *casting medals which are to be finished by the press*; and more especially when the alloy is not sufficiently malleable for the double impressions to be effaced, and for the metal to be introduced by the pressure into the cavities of the dies. It is then absolutely necessary that the models should be larger than the space between the dies; it is likewise requisite that all the contours of the casts should be rounded, and only sufficiently marked, for them to be placed properly in the dies; they thus avoid the double impressions, as no other traces can remain than those produced by the action of the press.

M. Jeuffroy was the first who endeavoured to compensate for the shrinkages in the cast medals. Entrusted with the execution of the medal of the Three Consuls, he had many difficulties to overcome, on account of the relief being so considerable. He thought, in order to submit this medal to the action of the press, of applying a foreign body to the surface of the model, thereby augmenting its volume: he accordingly applied a thin leaf of lead, which he caused to

adhere to all the details of the figures by the assistance of a burnisher: he thus obtained a medal, larger than the capacity of the dies which he used for making his casts from. The alloy which he employed, was composed of 75 parts of copper, and 25 of brass, which gives the proportions of 89,282 of copper, and 10,718 of zinc,—a very fluid alloy, and almost as malleable as pure copper, but which also experiences, in casting, a more considerable shrinkage than bronze. This process was too complicated to be entrusted to the hands of workmen; and the difficulties of applying the leaf of lead varied in different medals, and were considerably increased in the small models. It is to be regretted that M. Jeuffroy did not continue his experiments on the different alloys more durable than copper, and on various models.

M. de Puymaurin endeavoured afterwards to substitute for the leaf of lead, one or more coats of varnish; but this would not long adhere to the copper, on account of the hygrometric state of the air, and of the sand; it became soft, and adhered to the moulds. He afterwards tried to apply to the medals, by means of melted wax, a leaf of paper, which had been struck in the dies, so as to receive the forms of the relief. The moulding was afterwards very easily effected; and, by varying the thickness of the paper, he could nearly compensate for the greater or lesser shrinking. This augmentation likewise afforded the advantage of so rounding the contours, that they were only brought out by the action of the dies in the press. In another essay he caused the medal to be tinned all over its surface; its volume thus became uniformly augmented. The results which he obtained, were in general highly satisfactory, and the process became exceedingly simplified; as it only required a few minutes to prepare the models: the thickness of the tinning compensated for the shrinking of the casts, the contours were rounded, so that the marks of the mould were no longer perceptible, after the action of the press; and yet all the projections

were sufficiently marked for the placing the casts in the dies to be easily effected. This method having constantly succeeded in a great number of trials, M. de Puymaurin concluded that it might be applicable to the casting of medals of every description.*

In order to render this process equally applicable to the casting of medals, the relief of which is very considerable, and the raised parts opposite to each other, M. de Puymaurin thought of covering these raised parts only, with paper. To effect this, he imprinted the contours on the paper, by means of the dies in the press; and the sharp angles of the dies round the contours of the medal, having partly cut through the paper, round their outlines, it was easy for him to finish the cutting by hand, in order to apply the papers afterwards to the corresponding relieved parts of the medal. He heated the medal on a cast-iron plate to about 80° of the centigrade thermometer, and with a small hair pencil he covered the raised parts with a thin coating of melted wax, and applied the moulded papers upon them, which he made to adhere completely, by pressing them down with a pad of moist linen. The water with which the surface of the paper was damped cooled the wax, and caused it to hold the paper in form; he carefully removed, with a proper knife, all the wax which had spread over the surrounding parts, and afterwards thoroughly cleaned it with a piece of fine linen moistened with spirits of turpentine.† We may, in this manner, apply the process of moulding to the manufacture of all kinds of medals in bronze.‡ We have shewn that a great

* We must, however, except those medals, which bear on both sides considerable relief, the shrinkage operating in these places very unequally. But this circumstance seldom occurs.

† In order to vary the coating, according to the volume of the relief, it is sufficient to employ leaves of paper of a greater or lesser thickness. We may also repair the faults of a badly cast model, by laying wax more or less thick on the shrunk parts.

‡ Copper may also be cast and struck, but it is less fluid than bronze; we have also shewn that pure metal is not desirable in the numismatic art; as, under similar circumstances, it is much more liable to alteration, than bronze.

number of antique articles in bronze,—such as statues, vases, medals, arms, &c. &c. which have been found in various places,—contained certain proportions of copper and tin, and sometimes were alloyed with other metals.

In order to determine the fixed proportions of an alloy the most convenient for use, we must seek for those which afford a metal, at once the most dense, hard, and susceptible of easily receiving, both from the moulds and dies, every impression required in medals.* This is the object proposed by M. de Puymaurin in the second part of his *Memoire*, which is not yet completed, although he has made a great number of experiments, with his assistant M. Francfort. The result, however, appears to be, that, in the alloys of copper and tin, their hardness augments with the quantity of tin employed; but in what ratio, it has not been possible to determine, because very sensible irregularities have been remarked. It appears, however, to be demonstrated, that copper alloyed with from one to twenty hundredth parts of tin, has its density augmented a seventeenth part. It results also from the same experiments, that the limits within which we must comprise these alloys are very narrow. In fact, 5 hundredths of tin will produce a malleable alloy, but too porous; and 17 hundredths will form a bronze too hard to be employed in the ordinary manufacture.† Now, as it has been demonstrated that medals may be struck at the highest quality; and, consequently, at all the intermediate ones; it is evident that the problem is solved: and it is very likely that this new mode, the advantages of which are so great, will be generally adopted in the manufacture of bronze medals.

* We should likewise so determine these proportions, that the alloy may possess the most desirable bronze colour.

† M. de Puymaurin has, however, succeeded in making medals of every quality between these two limits. Among those from different models, which he had the kindness to strike in my presence, the greater part came very perfect, in three strokes of the press. We have analysed one of their jets, and found it to contain 10,25 of tin to 100 of copper. One of the medals, which he presented to me as a specimen, was composed, according to the analysis which I made, of 16,725 of tin, and 83,275 of copper;—its execution is extremely fine.

The alloy which appears best suited for the purpose, is composed of from 8 to 12 hundredths of tin, and from 92 to 88 hundredths of copper: its grain is very close, its surface is uniform; it is very dense and sonorous; is sufficiently malleable to take easily the most finished impressions from the dies under the press; and is so hard, as not to be injured by rubbing. We may add to it 2 or 3 hundredths of zinc, which will not sensibly change its properties, but render it susceptible of receiving a more beautiful bronze tint:—the addition of a very small quantity of iron does not appear to add to its useful properties, although there does not appear any obstacle to its employment.

The quaternary alloy of the Brothers Keller, which is susceptible of receiving so beautiful a tint of the *vert antique* (*patine antique*), succeeds equally well. In fact, it is evident that all these compositions of bronze may be employed in the manufacture of medals by this process, whenever they do not possess less malleability than the alloy composed of 16 hundredths of tin and 84 of copper; nor less fluidity in casting, than the alloy of 5 of tin and 95 of copper.

Casting of Medals in Bronze.—The necessary conditions to ensure success in casting medals, are, in general, the same as those which must be employed in casting bronzes of every description. We will briefly enumerate them, and then add some remarks, which are more particularly applicable to the article we are treating on. This operation, not requiring a great quantity of fused metal, must be done in crucibles, placed in the midst of charcoal fires, or perhaps better, of coke fires, and even of the hardest kind of coke; so that, in the same bulk, it may possess the greatest quantity of combustible matter, and, consequently, of the heat developed: circumstances, which afford a rapid fusion, avoiding the necessity of many charges of coals; and economizing both time and fuel.

Wind or blast furnaces are proper for the fusion of bronze. The first, however, which answers extremely well for fusing gold and silver, does not always possess

a draught capable of fusing bronze very rapidly;—an essential condition to the success of this operation. In fact, if an elevated temperature be continued long, or without quickly obtaining the proper degree of fluidity, the bronze becomes altered; the coat of oxide which forms on its surface, diffuses itself throughout the whole mass of metal when it is stirred; the alloy which results is porous, and the acid into which the medals are plunged, dissolves this oxide; a part of the metallic salts formed, remains in the metal, notwithstanding the washings; and the action of the press in stamping the medals, causes these salts to come into contact with the wrought surfaces of the dies; the steel is attacked by the acid, and the copper appears in its metallic state. A part of the proto-sulphate of copper formed, and the other salts, remain in the interior of the medals, and very soon change the beautiful polish on their surfaces, exhibiting in many places an efflorescent appearance. To avoid these various inconveniences, we must bring into fusion 5 kilogrammes of bronze, in 12 or 15 minutes.*

The bronze should be poured into the moulds at a certain temperature, which practice teaches, by the appearance of the metal. These, however, are the principal characters which it presents:—its colour is of a reddish white; a slight layer of oxide, melted in some parts, covers the surface of the metal; the metal itself, which is perceptible between the cracks, possesses a rather shining whiteness; we must then immediately skim off this oxide, stir the metal in the crucible, and pour it into the moulds.†

As soon as the bronze is poured into the moulds, we instantly open the frames, and withdraw the casts; then

* It would be well to keep the surface of the fused metal always covered with morsels of charcoal, which may be removed at the moment of casting.

† If the temperature was less raised, the surface of the metal would appear mammillated, and the metal would be thick or pasty; so that the minute cavities in the moulds could not possibly be filled: at a temperature too elevated, the oxide would enter into fusion, the whole surface of the metal would become of a shining white colour; the too lively action of the heat on the sand, would cause the production of a considerable quantity of gas, which not being able to escape, would diffuse itself amongst the bronze, and render it porous.

taking hold of the jet with tongs, we strike light blows, with a small wooden mallet, on each medal; which is thus instantly broken off, and falls into a tub filled with water; and there receives a cooling, which renders the bronze more malleable, and does away the necessity of annealing it.*

Medals are cleaned with a *scratch-brush*: each piece must be attentively examined, so that any which have irreparable faults may be remelted; we thus prevent the useless ones from passing under the action of the press.

[*To be continued.*]

VII.—*On a singular Method of Soldering, employed by Enamelled Watch-Dial Makers.*

These manufacturers, who form their dial-plates of thin rolled copper, enamelled on both sides, have a most ingenious method of soldering the short copper studs on their backs, by which they are secured to the frame-plates of the watches.

They require to be soldered with hard solder, but should they employ the common spelter solder for this purpose, the enamel would crack all across from the soldered places: they have, however, found that the following economical and convenient method fully answers the purpose.

The studs are made of *copper wire, plated with silver*; and at the places where they are to stand upon the plates, (which have been previously well cleaned, by the action of an acid,) four scratches are made with a sharp instrument;

* This cooling produces a contrary effect to that which takes place in steel;—an important observation, for which we are indebted to M. Darcet. This ingenious chemist has thought this property was applicable, in various manufactures of bronze, such as cymbals, gongs, mortars, pestles, nails for ships, &c.

In annealing bronze medals, they are heated to an obscure red; (large ones must not be so much heated, as they are in danger of melting; their temperature must only be raised sufficiently to fuse tin,) they are then plunged into cold water, and afterwards boiled in water acidulated with sulphuric acid, in order to cleanse them from a small coat of oxide, which forms on their surface.

namely, two parallel ones, the distance between them being equal to the diameter of the wire; and two others across, at right angles to the former ones; and the burrs thrown up, by the action of the instrument, thus form, as it were, a square embankment, which serves to keep the stud in its place. Borax, freed from its water of crystallization, and in the powdery form, is then mixed up with water to a thick consistence; and the foot of each stud being dipped into it, it is fixed in its place on the back of the plate. The plate is then laid upon a piece of charcoal held in the left hand of the workman, and exposed to the flame of a lamp urged by the blow-pipe; care being taken to heat it slowly at first, or till the borax has dried, and secured the studs in their places; *the heat is then raised until the silver fuses, flows down the wires, and firmly solders them to the plate.*

It should be observed, that the flame must not be urged directly upon the feet of the studs, which should be kept as free from it as possible; but only on their upper ends, and the neighbouring parts of the plate.

We think that this curious manner of soldering, which has hitherto been confined to this business alone, may be applicable to other purposes; at any rate, it is well worthy of being made trial of.

We are indebted to Mr. Edmund Turrell, for the knowledge of this ingenious process, which was long kept secret in the trade.

VIII.—*On the Culture of the Beet, in France, for the Extraction of Sugar and the Nourishment of Cattle.**

There are two varieties of the common Beet. The *Beta ravia (petroz)* has a plump root, larger than that of the beet, with smaller leaves; it is a biennial. In the first year its root attains perfection, acquiring the *maximum* of its extractive principles towards the end of September;

* From the *Dictionnaire Technologique.*

the stem, which bears the seed, rises in the second year, at the expense of the root, which then totally loses the saccharine qualities it before contained. This variety is cultivated in the gardens; its root is eaten in salads: in the country it is used for the feeding of cows, and greatly increases the quantity of milk. One of its most interesting products, however, and for which it has been largely cultivated for some years past, is sugar, which is extracted in the large way. In fact, the cultivation of the beet became of the greatest importance, when the French chemists and manufacturers, availing themselves of the discovery of Margraff, and the important labours of Achard, succeeded in extracting a sugar from it, completely identical with that produced by the canes. The want of communication with our Colonies, the loss of which appeared certain; and the shackles which were placed upon our maritime commerce, had raised the price of this Colonial production to a most exorbitant height. The prohibitive system which then prevailed, determined the French government to call the attention of men of science to some means of substituting, by indigenous products, those substances become, by habit, articles of absolute necessity; and which the two Indies had, for a long time, exclusively furnished to us. French industry was very soon seen to apply the first discoveries that had been published, and to manufacture, in the large way, products which, more or less advantageously, supplied the place of the sugar from the New World, in many of its employments. These processes being brought to perfection in the hands of able workmen, gave the most satisfactory results. Nevertheless, the best clarified honey, and the whitest syrup or sugar from grapes, were far from possessing those qualities which characterized the Colonial sugar: it became the national interest to create a strong prejudice in the minds of certain persons in favour of them, and that they might not perceive the enormous difference which existed between these syrups and the sugar from canes,—a difference wholly in favour of the latter.

M. Deyeux transmitted to us the labours of Achard in Germany, and repeated, with M. Barruel, the experiments on the extraction of sugar from the beet. Many scientific men engaged themselves in this interesting subject; and in a short time the perfect identity of this sugar, (when properly refined,) with that from canes, was made known; and French industry, anew solicited and powerfully encouraged, made immense efforts to arrive at an economical mode of preparing it. All the departments in France made trials; and in the space of two years, more than two hundred manufactories of sugar, from the beet, furnished to the refineries, or brought directly into the market, vast quantities of sugar, which was made use of, without the nicest judge perceiving the difference. We have seen advertised in the shops—"*Miel depuré, Sirop de raisin de Bergerac* (Purified honey, Syrop of Bergerac grapes); and they had also discovered *sugar of milk* in the coarser sugars, &c.; and the discredit which these indigenous products well merited, naturally tended to bring the beet sugar into disrepute. They then feared, and with reason, to declare publicly the origin of the latter, and it was sold under the name and in the form of refined sugar from the Colonies; and, as it possessed all its properties, it was not distinguishable from it, in spite of the prejudices which threatened to prevent its use; and amongst those who have consumed the most of it, there are even yet some who doubt its existence; or, at least, that it can be substituted for the sugar from canes.

Even when the high price of sugar in France afforded the greatest advantage to the extraction of sugar from the beet, the uncertainties in the process of its manufacture, in its mode of culture, in the choice of the soil, and in the variety to be cultivated; the imperfection of the instruments employed in rasping the roots, so as to extract the juice; and, in fact, all the inconveniences attending the hurry in which these manufactories were erected, caused most of these manufacturers to experience great losses.

During the first two years of the establishment of this new branch of industry, many manufacturers were so discouraged, that they abandoned the pursuit; and those who with great difficulty persevered, were scarcely in a state to profit by these lessons of experience, when great political events suddenly caused a considerable diminution in the price of sugar. The establishments built for the purpose of manufacturing beet-sugar had to compete with the introduction of foreign sugar; and the result of this was, a nearly entire overthrow of these manufactories, which seemed to have received a death-blow: nevertheless, some of them survived the Peace, and, in spite of the progressive diminution in the value of sugar, the manufacturers were not all discouraged—a twentieth part of these establishments escaped the general wreck, bore up under these distressing circumstances, and hope still to be able to continue the manufacture of beet-sugar.*

A singular result, from unforeseen events, and which we may here remark, is, that the French Colonists are now in a similar condition to that of the manufacturers of beet-sugar; as neither of them can stand any chance with the very great quantities of sugar imported from India: both claim an augmentation in the value of their products; and it is requisite that they should be supported by this means, and without which the trade of India would infallibly crush them.†

If, in other respects, we continue the parallel between our indigenous sugar manufactories, and those of the Colonies, many other curious facts will appear. The same extent of land cultivated for beet, under the best circum-

* Some manufactories, according to the account of the manufacturers after the experience of twelve years, appear to be able to maintain themselves, independent of any augmentation in the price of sugar, as required by our Co onists.

† The product of raw-sugar, from the soil in the Antilles, is, on an equal surface, one-half less than that obtained in Bengal; and the day's work of a free man, in the latter country, only costs one-third of the price that a day's work of a negro amounts to in our Colonies: the expense also of manufacturing raw-sugar in India, costs only one-fourth the price of that manufactured in the Antilles.

circumstances, in our departments, and for sugar-canes in our Colonies, will produce the same quantity of sugar. One *hectare* in beet, will furnish at a *maximum*, 2,500 *kilogrammes of sugar*; and on ordinary land, from 1,000, to 1,200. The extracting and refining of sugar from the beet was at first attempted in France, by very different means to those employed in the Colonies;—it then afforded but little success, when applied in the large: they have lately adopted the methods used in the Colonies, with some successful modifications, and the operation in the large has completely succeeded. The cylindrical rollers, so very useful in the treatment of the beet-root, are an imitation of those used in the Colonies; the important improvements, successively introduced in the treatment of the beet, are nearly all applicable to that of the canes, and they are at this time adopting them in the Colonies.* In fact, for several years past, steam-engines have been introduced into the sugar manufactories, to save the manual labour before employed, in extracting the juice from the canes; and the Duke of Ragusa is about to have erected in his beet sugar manufactory, a steam-engine of twelve-horse power, made in Paris. Howard's improved process for sugar-boiling still remains to be applied, both in France and in our Colonies,—in the treatment of beet, as well as cane sugar; and this, we think, cannot fail to produce the best results.

These general observations, we have thought it our duty to give, before we proceed to notice the culture of the beet, and the extraction of the useful juice it contains; in order that we may duly appreciate the degree of interest which the operations of this manufacture afford in France.

Culture of the Beet.—The culture of the beet, for

* During the last year, I have been engaged in preparing and applying various improvements in the sugar manufactory of M. Dehaumont, a proprietor at Martinique; and particularly those which have been approved in our manufactories of sugar from beet, and in our refineries. M. Derosne and M. Gallard are engaged in the same object at Guadaloupe.

the purpose of extracting its juice, merits, as we have before observed, the highest consideration; and especially as a part of the plant (nearly one-half) may be employed in the feeding of cattle, and in manuring the land:—it is, however, cultivated for the use of cattle only. In the environs of Paris, for instance, the high prices of labour and land will not permit of the sugar being manufactured, at a price equal to that which we now receive from the Colonies: but still, it can be cultivated with advantage for the nourishment of cows; as it enables them to give more milk, and of a much better quality, than most other vegetables. The beets destined for this purpose, are much more easy to cultivate, than those which are intended for making sugar.

They choose a strong soil, although light, and well manured. The seed which produces the largest beets is also preferred, because it affords a greater product in weight; the variety called *dissette* is that which offers this advantage in the most eminent degree.

The beets which are cultivated for the manufacture of sugar require more care: their form, texture, the quality of their juice, &c.—are to be considered.

We shall now give a list of the varieties of this root; and the observations which we have made relative to the quality of the juice which they contain.

First variety.—*Dissette* (*Beta silvestris*), *field beet*, is white internally and externally; and the footstalks of the leaves are also white; on a light, and rather moist soil, it produces very large and heavy roots; it is cultivated with advantage for the feeding of cattle.

Sub-variety.—This is red on the outside, and presents internally, (if cut across, or perpendicularly to its axis,) concentric circles of red and white; it has red and white footstalks to its leaves. The seed of the former is preferred.

Second variety.—White beet of Silesia (*Beta alba*), is round, pear-shaped; has white petioles; is white internally, and of a firm texture; it resists hard frosts and inclement

weather better than any other:* it is difficult to rasp; produces very little juice, especially in dry seasons (from 60 to 65 lbs. from 100 lbs. of roots); its juice marks from 7 to 10 degrees; it is very saccharine, and easy to *work*; it affords from 6 to 8 in the 100 of raw sugar, equal to from 4 to 6 of *refined*. It has been recommended by Baron de Koppy, Achard, &c. As it does not throw out very long roots, its culture offers great advantages, compared with the other varieties, in soil which is not very deep. By means of an hydraulic press, we can obtain from 65 to 70 in the 100 of juice. The varieties given under the numbers 1, 4, & 5, afford, by the same means, from 75 to 80 in the 100.

Sub-variety.—Its petioles are veined with red; and it has concentric circles of red and white in the interior of the root.

Third variety.—Is white and slender; it strikes out of the earth, and is never cultivated.

Fourth variety.—Red beet (*rubra romana*) is oblong, and well-shaped, the petioles of its leaves are red; it is seldom cultivated but for the table. These are its *sub-varieties*.

1st *Sub-variety.*—Is of a yellow colour, and the petioles of its leaves are yellow.

2d *Sub-variety.*—Is rather of a reddish colour, carrot-shaped; its petioles and its flesh are red, mixed with yellow.

3d *Sub-variety.*—Is rather of a reddish colour, round, in the form of a turnip; ripens early (twelve or fifteen days), is cultivated in gardens; and is boiled to be eaten in salads.

Fifth Variety.—Yellow beet (*lutea major,*) is of an elongated carrot shape; of a middling size, the petioles of its leaves are

* M. Lestelle observed that, in February 1820, at a temperature 8° below zero, they brought beets more than half a league, whose tops had been cut off with the spade at the moment of digging them: they were healthy; were very easily rasped, pressed, and cleaned; and afforded the finest sugar. This very remarkable property has caused them to be preferred in many places to the yellow beet, which is liable to be injured by the least contusion, or from a slight frost.

of a greenish yellow; if well cultivated, it yields an excellent product in weight, and is very easily rasped; the juice extracted from it is very saccharine; it commonly marks from 5 to 7 degrees of the *areometer*, and produces from 4 to 5 in the 100 of raw sugar, equal to from 2,5 to 3 of refined sugar.

1st *Sub-variety.* It is of a red colour, has red petioles; is always mixed with those above described, although the seed sown may be entirely yellow; when the seeds, in four cells, grow upon the same stalk, it often happens that three of them are yellow, and one red.

[*To be continued.*]

IX.—*On the Great Superiority of the Limerick Fish-Hooks: and a Query on preventing Hard Woods from Warping or Cracking.* *By* A CORRESPONDENT. *With Remarks by the* EDITOR.

SIR, *Amesbury, Wilts, June 22d*, 1823.

I TAKE the liberty of directing your attention to a subject which is very interesting to myself, and may prove equally so to many others of your readers; and, as it is connected with the tempering of steel, cannot, I imagine, be foreign to the purpose of your excellent Repository.

The subject which I allude to, is the manufacture of hooks for trout and salmon fishing; and I wish to be informed, what impediment prevents the English artist from producing a hook, equal in *shape* and *temper* to those made in Limerick, where, I believe, they do not profess a superior excellence in any other hard-ware manufacture.

I beg leave to say, that I have made trial of all sorts of hooks, during many years experience, and find none to be compared with the Limerick for strength, neatness, and bend. A Mr. Bolton, of London, produced, some years since, a beautiful imitation of them to the *eye*; but the points were too much *thrown outwards*, and they were so extremely brittle, that both the points and beards *flew* five

times out of six. I think they must have been *cast* and not wrought steel.

The spurious Limerick hooks, generally sold in London, are miserable trash; and made only to exercise the patience of the angler, who is so unfortunate as to be reduced to the necessity of making his flies upon them.

Your noticing this subject, may, perhaps, induce some manufacturer to turn his attention to it; and, to prove that it is no very difficult task, I inclose an imitation of my own; which, on trial, I find, though not equal to the Limerick, are certainly superior to the English.

I make them of iron wire, of rather a larger diameter than is generally used, that I may file them thin, where strength is not required, and leave them thicker, where it is necessary. I then convert them into steel, harden them, and blaze them off in the candle, with oil or tallow.

I have not been able to put a good black varnish upon them; and shall feel obliged by your favouring me with information on this head.

Living in a retired village, where the art of tinning a kettle is a secret and mystery, not to be revealed to any but *the trade*; you may guess, Sir, what useful aid I have derived from your publication, in my mechanical amusements; and entirely agree in the opinion of a former correspondent, who suggested, that in your communications and explanations, you could not be *too particular* or minute, for many of your readers.

I remain, Sir, your's, a constant reader,

T. Gill, *Esq.* A. M.

P. S. The French, I understand, cover all the hooks that are used in *sea-fishing*, with a coat of *tin*; which prevents them from corroding, and attracts rather than frightens the fish, by its brightness: in every other respect, however, they are inferior to the English hooks.

Any information on the subject of preventing hard woods used in turning, from warping or cracking, would, no doubt, be very acceptable to many of your readers.

Remarks by the Editor.

We have long since had our attention directed to the great superiority of the Limerick fish-hooks over those of English manufacture; and, particularly, by Sir Thomas Frankland, Bart. who had himself paid great attention to the subject.

We believe, that one great cause of the *rottenness* of the English fish-hooks arises *from the great length of time they are exposed to the annealing process*, to render them sufficiently *soft* to enable the makers *to cut the barbs with a knife*; and which must certainly injure the wire; and also, from this operation of *cutting the barbs*, which greatly tends to cause them to break off, as mentioned by our esteemed correspondent.

Sir Thomas Frankland assured us, that the Limerick fish-hooks *have their barbs filed entirely out of the solid.* We shall in our ensuing Number give further particulars hereon, with Figures.

The Limerick hooks sent us by our correspondent had evidently been defended by a black varnish; but whether of japan, or lacquer, we are uncertain.

The Dutch are in the habit of boiling the wood of which the wheels of their clocks are made, in oil; and this process, no doubt, greatly contributes to prevent it from warping or cracking.

X.—MISCELLANEOUS.

Mr. H. R. PALMER'S *Improved Rail-way, &c.*

IN our First Volume, p. 287, we gave a short description of this novel invention. Mr. Palmer has sent us a small treatise which he has just published, in elucidation of the subject, accompanied with two explanatory engravings; one of them representing a considerable portion of the rail-way, as in use, and the methods of overcoming the several ob-

stacles that most frequently occur in its application to practice; such as a jointed-rail, or gate, used for crossing private roads; the mode of crossing a fordable stream; a rail-bridge adapted for rivers; a turning-rail, by which the waggons are transferred, two at a time, to a branch at right-angles, &c. The other engraving affords a detail of the construction of the rail-way, and the carriages for it. There is also a description of an improved dynamometer; observations on the rail-ways now in use; and a Table of the comparative resistances on several of them.

Mr. Palmer states, that, "in order to retain a perfectly smooth and hard surface, unencumbered with the extraneous obstacles, to which the rails near the ground are exposed; it appeared desirable to elevate the surface of the rail above the reach of those obstacles; and, at the same time, to be released from the impediments occasioned by snow in the winter season. This also appeared to afford a better opportunity of adjusting and retaining the plane. To elevate two lines of rail, for the purpose of supporting a carriage, could not be accomplished at a sufficiently moderate expense: I therefore endeavoured to arrange the form of a carriage in such a manner, that it would travel upon a single line of rail, without the possibility of overturning. Having then, but one line of rail to keep in its right position, and that so high above the surface of the ground, as to be completely under the command of hand; the adjustments, so much required, appeared at once practicable."

"A perfect and adjustable plane being obtained, no farther preparation is necessary for the moving power, than an ordinary towing-path. The horse is connected by a towing-rope to the carriages, and proceeds on one side of the elevated rail; and, as his height will vary with the undulations of the surface, he will sometimes be below the rail, and is, consequently, provided with a length of rope, which will enable him to vary his height without much altering the angle of draught."

"The advantages to be derived from such a disposition are, that we are enabled to construct, in many cases, with precision, that plane which is most effectual; and where the shape of the country would occasion too great an expenditure, on the former plans. It is, as before said, unencumbered with extraneous substances, and is retained in perfect adjustment, at a trifling expense. It is not interrupted by snow, as a brush, preceding the first carriage in a train, will clear all that can lie upon the rail; and the receptacles for the load are too far from the ground to find any impediments there. The arrangement also enables us to continue a conveyance by other means, with very little interruption; as it is evident, that the receptacles may be transferred from the one, and lodged upon another kind of carriage or vessel, separately from the wheels and framework, without displacing the goods. The receptacles being suspended, their weight preserves their position; and the articles conveyed, are therefore, not liable to fracture. *A vessel of water may be thus conveyed, without losing a drop.* The rail may be constructed on the side of a public road, without occupying more space than can usually be afforded; and its effect need not be diminished by the dust, &c. from the road, as is the case in other rail-ways. It may also be erected on the waste and irregular margins of rivers, which, on account of the number of culverts and bridges usually required, has hitherto been too expensive. From the removal of a great portion of resistance, the effect which can be produced upon it, is greater than has before been performed. The original cost, in those cases to which it is adapted, and where it offers most advantages, will be much less than in the ordinary plan: in fact, it enables us to obtain a more direct line, and to approach nearer to the best inclination, and at a less cost, than has before been done; and to keep it in repair, at a much cheaper rate. It occupies less land, and is, therefore, less objectionable to land proprietors. The carriages may also be impelled by steam, applied either as a loco-motive, or

stationary power; and they admit of expeditious conveyance, with perfect safety."

For these reasons, and for many others, which might easily be pointed out, we trust that this highly useful invention will soon be brought into general use.

A singular occurrence prevented the earlier appearance of this treatise:—the original manuscript was delivered to Mr. Taylor, of Holborn, only the evening before his Architectural Library was burnt down; so that it had to be written entirely over again.

New Dyes for Silk, &c. from Prussian Blue.

Mr. Richard Badnall, jun. of Leek, Staffordshire, has lately discovered a method of employing Prussian Blue in Dyeing Silk &c. so as to procure as permanent Dyes from it, as those usually obtained from Indigo, and with far greater advantages, in respect to the beauty and brilliancy of the colours.—We have seen a variety of entirely new tints of blue, which he terms *sapphire blues*; besides many other blues, greens, purples, &c. produced by the use of it, together with other Dyeing materials.

An Improvement in Silk throwing.

Mr. Badnall has also effected a very considerable improvement in this useful process; by which, in case of one of the two threads which are being twisted together, breaking, the other is instantly cut also; and in a much simpler and better manner than heretofore.

Mr. Badnall has obtained his Majesty's Royal Letters Patent, for this valuable improvement: and another for his substitution of Prussian Blue in place of Indigo, in Dyeing Silk, &c.

LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal, since May 27, 1823.

To Edward Ollerenshaw, of Manchester, in the county of Lancaster, Hat Manufacturer; for a method of dressing

and finishing Hats, by means of certain machinery, and implements to be used and applied thereto. Dated May 27, 1823.—To be specified in six months.

To Thomas Peel, of Manchester, in the county palatine of Lancaster, esq.; for a Rotary Engine, for the purpose of communicating Motion by means of Steam, or other gaseous media. Dated May 27, 1823.—In six months.

To Stephen Wilson, of Streatham, in the county of Surry, Esq.; who, in consequence of his own discoveries, and communications made to him by foreigners residing abroad, is in possession of certain improvements in machinery for weaving and winding. Dated May 31, 1823.—In six months.

To John Mills, of St. Clement Danes, in the county of Middlesex, and Silver Street, in the city of London; and Herman William Fairman, of Silver Street, in the city of London, Merchants; who, in consequence of a communication made to them by a certain Foreigner residing abroad, are in possession of certain improvements in rendering Leather, Linen, Flax, Sail-Cloth, and certain other articles, water-proof. Dated May 31, 1823.—In two months.

To Richard Badnall, of Leek, in the county of Stafford, Silk Manufacturer; for certain improvements in Dyeing. Dated June 3, 1823.—In six months.

To Thomas Attwood, of Birmingham, in the county of Warwick, Banker; who, in consequence of a communication made to him by a person residing abroad, is in possession of certain improvements in the making of Cylinders, for the printing of Cottons, Calicoes, and other articles. Dated June 3, 1823.—In six months.

To Thomas Mills, of Dudbridge, near Stroud, in the county of Gloucester, Cloth Dresser; who, in consequence of communications made to him by certain Foreigners residing abroad, is in possession of certain improvements in Machines for shearing or cropping Woollen Cloths. Dated June 3, 1823.—In six months.

To Jacob Perkins, late of Philadelphia, in the United

States of America; but now of Fleet Street, in the city of London, Engineer; who, in consequence of communications made to him by certain Foreigners residing abroad, and discoveries by himself, is in possession of an invention of certain improvements in Steam Engines. Dated June 5, 1823.—In six months.

To Edward Cowper, of Kennington, in the county of Surry, Machinist; for certain improvements in Machines and Apparatus for printing Calico, Linen, Silk, Wool, Paper, and other substances, capable of receiving printed impressions. Dated June 10, 1823.—In six months.

To Robert Mushet, of the Royal Mint, Tower Hill, in the county of Middlesex, Gentleman; for a mean or means, process or processes, for improving the quality of Copper, and alloyed Copper, applicable to the sheathing of ships, and other purposes. Dated June 14, 1823.—In six months.

To Richard Pew, of Sherborne, in the county of Dorset, Esq.; for a new composition for covering houses, and other buildings. Dated June 17, 1823.—In two months.

To Charles MacIntosh, of Crossbasket, in the county of Lanark, Esq.; for a process and manufacture, whereby the texture of Hemp, Flax, Wool, Cotton, and Silk; and also Leather, Paper, and other substances, may be rendered impervious to water and air. Dated June 7, 1823.—In six months.

To James Smith, of the Borough of Droitwich, in the county of Worcester, Civil Engineer; for an Apparatus for the applying Steam to the boiling and concentration of solutions in general; crystallizing the Muriate of Soda, from brines containing that Salt; melting and refining of Tallow and Oils; boiling of Sugar; distilling, and other similar purposes. Dated June 19, 1823.—In six months.

THE

TECHNICAL REPOSITORY.

XI.—*Explanation of the Measures taken to do away with the Inconvenience arising from Copper Smoke. By* J. H. VIVIAN, *Esq.* F.R.S. *&c. With some Observations on other Plans that have been suggested as likely to effect this Object.*

[Continued from p. 20.]

5th. CALCINATION IN CLOSE VESSELS.

THE question has, more than once, been put to me—Why not calcine the ore in close vessels, and obtain the sulphur by distillation? The answer is obvious,—because the sulphur, in the proportion and state of combination in which it is contained in the Cornish ores, cannot be distilled off, at least not in any quantity; and if it could, no smelter or refiner could do any thing with the residuum; as, without the acid of sulphur, the metallic contents of the ore could not be effectually separated from the earths; nor would the copper, that would result therefrom, be refined. The fact is, that the object of calcination, is not only the expulsion of the sulphur and volatile substances; but, as the old term denotes, the oxidation of the iron, and other metals combined with the copper; and for both these purposes, a free and copious admission of atmospheric air into the furnaces, is highly requisite. In proof of the good effect of a current of air through the calciners, we may refer to the steam experiments; in which it has been found that the water has usually contained the greatest quantity of sulphur, when the air-holes in the bridge of the calciners were open; and likewise, to the fact, that the metal (metallic sulphuret) has been much better calcined, since the

alterations in the interior of the chambers, by which the draught has been improved, and the current of air passing through the calciners increased; than when its passage was checked, by the smoke being made to ascend and descend through the vertical divisions; although the heat in the calciner was, in that case, nearly as good as at present.

I admit, that if the calcining furnaces could be so constructed, as to allow of the processes being carried on as efficaciously as at present, and the smoke produced from the fuel, could be kept distinct from the ore,—that it would be a great point gained; inasmuch as many of the objections to the condensation or decomposition of the sulphurous acid, by chemical agents, arise from the diluted state of the gas. But what kind of furnace, fit for this purpose, could be employed; and applied in a work, in which, perhaps, from 4 to 500 tons of ore, and from 2 to 300 tons of metallic sulphurets, are calcined weekly? What an immense loss and embarrassment would be occasioned, by a total derangement and alteration of the existing establishments? What would be the number of furnaces required? Of what materials could they be constructed, so as to communicate the heat, and not be destroyed by it, or by the acids, or by their joint action? Bricks would not answer, as being bad conductors of heat, and liable to chemical action; and iron would be instantly destroyed. What would be the additional consumption of fuel, for heating these furnaces, in which the fire was applied externally, and no direct communication between it, and the substance to be acted on? And, after all, numerous mechanical and chemical difficulties, attending the application of the condensing or deoxidizing agent, would still exist*.

* Other modes of condensing, or decomposing the sulphurous acid gas, are known to persons acquainted with chemistry; but they are so totally inapplicable to practical operations, as to be scarcely deserving of notice; as, for instance:—

Condensation by alkaline lixivia, or *absorption of the acid, by the ammonia from burnt bones*.—In these cases, neutral salts would be formed, totally divested

It must, I think, be evident, from the foregoing remarks, that no beneficial effect can be practically obtained, from the use of any direct chemical agent; and, after the most mature and deliberate consideration, and after the most anxious inquiry, I can only add, to what I have before stated, *my conviction,—that, in order to effect the proposed object, the agency of water is the most simple, the most secure, and the most effectual that can be employed; and indeed, the only one that is applicable to a working scale; for, whilst the use of it offers comparatively few difficulties, it possesses the great advantage of freeing the smoke from fluoric and arsenious compounds, which would not be perfectly effected by any other method.* It is not, however, in all situations, that a sufficient quantity of water can be obtained. In such cases, I know of nothing more that can be done, than to deliver the smoke into the air, at as great a height as possible, so that it may lose its high temperature, and be diluted with atmospheric air, before it is brought into contact with vegetation. The mode of effecting this, must depend on local circumstances; in an open flat, a stack of the height of 150 or 200 feet, will, no doubt, be of great service. If there is a rising ground in the immediate neighbourhood of the works, an underground flue may be carried up the side of the hill, and a chimney placed at the end of it; but where water is to be had, I strongly recommend its use:—in every way it must do good; even as a running stream in the bottom of the flue, it would assist by direct absorption; and would act by its cooling power, if the quantity was considerable, in condensing vapour;

divested of the noxious or disagreeable character of copper-smoke: but the material required, even if it could be obtained, would cost as much, or more, than the value of the copper produced in the Work.

Decomposition by hydrogen.—Pure hydrogen would be even a more expensive agent, and liable to more mechanical difficulties in its application, than carburetted hydrogen (considered in the Postscript); and for this reason,—that, from its lightness, the same bulk of it contains only a very small proportion of reducing matter; consequently, it would be less effectual in producing decomposition, whilst it would be more expensive in its production.

which would carry down sulphurous acid with it: *but certainly, the most efficacious and most economical mode of applying it, is in showers, where the division of the water into drops presents an extent of surface that cannot be obtained in any other way*; except, indeed, by the application of steam, which I have shewn, on other accounts, to be disadvantageous.

The showers may either be admitted into the flue itself, or into chambers; the latter I think preferable. The extent of these chambers must, of course, depend on the supply of water, and on the means of supporting the draught from the calciners. The number of divisions must also, in some measure, be regulated by similar circumstances. It is obvious, that the more divisions there are, the more uniform will be the circulation of the smoke through the chamber, and its exposure to the action of the water; whilst the wet walls will offer additional condensing surfaces, and serve to arrest the vapours, and any matters held in mechanical suspension. But it is also evident, that these obstructions must naturally tend to check the draught; and for this reason, if the partitions are numerous, I think it advisable to let the smoke traverse the chamber horizontally: if, however, there is only one partition, it may be placed in the middle of the chamber, and the smoke be made to pass over it, as in the first chamber in the metal calciner flue at Hafod, (a section of which is shewn in Plate I.,* under the letter M). A single partition of this sort, breaks the current of the smoke, and prevents its passing through the chamber undisturbed, as it would do if the space was left entirely open. The showers may be introduced from the greatest height that can be obtained, the elevation of the chambers being regulated accordingly, and the divisions narrowed, in proportion to the height of the fall above the horizontal flue, so as to bring the water into contact with as much gas

* This Plate was given in our preceding Number.—EDITOR.

as possible; taking care, however, for the preservation of the draught, not to reduce the area of each division, below the area of the horizontal flue; but rather to allow for the space occupied by the water, and for the obstructions caused by the angles of the partitions. Another point to be attended to, is, that the water be passed out of the chamber as soon as it has done its duty; as, by remaining exposed to the heat from the furnaces, its temperature would be increased, and it would give off a portion of the gas, which it had previously absorbed. On the size of the holes in the shower-pans, and their arrangement, I have offered some remarks in the former part of this Report.

With respect to the form and construction of the horizontal flues, and the high stack; the arrangement of ours at Hafod is shewn in the accompanying plans and sections. It is well known, that the draught of reverberatory furnaces may be maintained through an underground flue, if the smoke is not subjected to washings, and the stack of great height, and contiguous to the works; as a high temperature may then be preserved throughout the flue; but, where the smoke has to pass through a succession of shower-chambers, I think an elevated flue decidedly preferable, although it may cost more in the outset; as, by making the flue ascend immediately from the calciners, a draught will be produced, that will be beneficial to the process, and will prevent the escape of smoke into the works, when the doors of the furnaces are open; whilst the rarefaction of the air in the stack, will maintain the draught, through, and after the condensing process.

The high temperature in the stack, may be produced by a single melting furnace drawing directly into it; or the stack may be placed so near to the works, and be built of such large dimensions, as to admit of the melting furnaces generally, being connected with it, by means of horizontal flues, distinct from those from the calciners. The joints of the flues, if built on arches, should be made close, to

exclude atmospheric air; or, if the situation will admit of it, the flue itself may be covered with earth.

From these details, it will be obvious, that I have given the subject every possible consideration and attention; that no exertion, on my part, has been wanting; and that no expense, on the part of the proprietors of the Hafod Works, has been spared; to effect an object, the attainment of which, we have felt to be so highly desireable. The actual expenditure of a sum exceeding 6000*l.*, (not to mention incidental expenses; such as the extra consumption of coal and materials, occasioned by the stoppage of the calciners, in altering the flues; as well as the direct and constant expense attendant on the diversion of a part of the water from the Forest Mills)—affords ample testimony of our earnest wish, as far as we are concerned, to give the inhabitants of Swansea, and its vicinity, all the advantages of the Copper Works, without subjecting them to any of their inconveniences. That we have not been urged to this, by any proceedings instituted against us, is very evident, from the circumstance, of our having commenced our operations before the question was ever made a subject of consideration for a jury. That we did not desist in our endeavours, after the failure of the first attempt to bring it into Court, I have also shewn. *And, if we cannot flatter ourselves, that we have absolutely, entirely, and effectually got rid of every particle of the matter, which has been considered as producing inconvenience; we may, at least, affirm, that we have abated it, to a degree beyond the possibility of its producing, as far as our Works are concerned, future cause for complaint:* and we feel confident, that the liberality of the inhabitants of Swansea, and the immediate vicinity of the Works, will do us the justice to believe, that we have been stimulated in our endeavours to effect this, much more by a sincere desire on our parts to meet their wishes, and by a sense of the advantages

that would arise to the town and neighbourhood; than by the hope of benefiting ourselves, or the fear of the consequences of any proceedings against us in a Court of Law; for, on this head, we could not but find our security, in the belief, that a measure so fatal to the best interests of the town of Swansea, and county of Cornwall, as an attempt to stop the Copper Works, would never be really resorted to, and persisted in; or, if it were, in the certainty that, of such importance is the manufactory to the country generally, that it would be found necessary to afford it legislative protection: for, the same arguments that might be used against the inconvenience arising from the Works on the Swansea river, would apply to all other Works; and the stoppage of one, would, assuredly, be found a precedent for the stoppage of the whole.

I am well aware that it might be said, that the Copper Works may be removed. But where, let me ask, is the situation to be found, where the same objections do not already exist, or would exist very shortly after the erection of the Works? For, if it were possible to suppose the Works could be removed to a spot distant from the haunts of man, where a convenient river and a plentiful supply of coal were to be had; still, it must be very obvious, that habitations, and even towns, must soon arise about them; some of the inhabitants of which, would, in a very few years, perhaps, complain of some inconvenience from that which was the first great cause of the rise and prosperity of the place. If, in short, the Copper Works are a nuisance, let every possible means be taken to abate that nuisance: but, if that abatement can only be satisfactorily effected, either by their being stopped or removed; then, indeed, must the manufacture of Copper in Great Britain be entirely at an end.

Marino, Nov. 26, 1822. JOHN HENRY VIVIAN.

P. S.—Since the preceding Statement was written, the gentlemen appointed as judges, have held their final

Meeting, and made their Report; and, having in that Report recommended some farther experiments to be made, on the decomposition of the sulphurous acid gas by carbonaceous matters; desirous of meeting the views of those, to whom, for their patient and laborious investigation, and great and unremitted attention to the business, during the whole course of the arduous enquiry, to which they gave themselves up, I consider, we have all so much reason to feel obliged; I determined, notwithstanding the decided opinion I had formed and expressed, to repeat the trials I had made with stone-coal (which is an almost pure carbonaceous substance, free from bitumen and earthy matters), and with coke; and I requested the attendance of some scientific gentlemen, who were at that time on a visit in the neighbourhood, to witness the results.

Our first experiment was, to pass the smoke through a stone-coal fire, made in the small experimental furnace, near the stack. The result was precisely similar to that we had obtained in our former trials: the fire was so close and compact, that not an atom of gas would pass through it; nor could the passage have been effected, as was observed by one of the party present, without the aid of a steam-engine, on a scale equal to the magnitude of the Works.

I likewise repeated the experiment with coke; with no better success.

CARBURETTED HYDROGEN.

Under this head I shall notice some experiments I undertook at the suggestions of chemists of great eminence, for effecting the decomposition of the sulphurous acid, by hydro-carbonous gas distilled from pit-coal. The apparatus consisted of a small platform, constructed in front of one of the ore-calciners; over which, the smoke and flame were made to pass, in their way to the stack. This platform was covered with binding coal, leaving a free passage for the smoke over it. On the disengagement of

the carburetted hydrogen gas, by the heat from the flame that passed through the calciner, some chemical action was to be perceived; but, I confess, I cannot but consider it, like all the other attempts at decomposition, as a mere laboratory experiment, and totally inapplicable to a working system; for, although it may appear, at first sight, that some of the objections I have stated against the use of charcoal, do not apply to hydro-carbonous gas; still, the mechanical difficulties attending the practical and successful application of the latter, are great; and, as I conceive, insurmountable.

The advantages which carburetted hydrogen as a deoxidizing agent, applied as above described, has, over charcoal; are, 1*st*, That the draught from the calciners is not obstructed; 2*dly*, That the agent employed is in a gaseous state; and, consequently, can be brought into more immediate contact with the gaseous body on which it is to act; 3*dly*, That the aid of an external fire is not required, to keep the substance in the state of ignition; and, 4*thly*, That there is a possibility of obtaining the material employed.

But it appears to me, that the following objections to the plan, still exist:

1*st*, An entirely new construction of the furnaces would be required; or, at least, such alterations, as would greatly embarrass, if not totally detroy, the present arrangement, and system of the Works.

2*dly*, It is a matter of doubt with me, whether the waste heat of the calciner, would be sufficient to cause the distillation of any considerable portion of the gas from the coal.

3*dly*, The great expense and inconvenience, of charging the furnace with coal, keeping fresh surfaces exposed, removing the coke after distillation, cleaning out the deposit, &c.

4*thly*, That carburetted hydrogen is afforded by coal only, when heated without the access of atmospheric air;

or, if given out in the presence of atmospheric air, is burnt at the moment of its evolution; for, it cannot be supposed, that the hydrogen and the carbon would unite with the oxygen already combined with the sulphur; rather than with the unconsumed oxygen, passing through the furnace.

And, *5thly*, The difficulty of supplying a condensing agent. Supposing the sulphurous acid to be decomposed by the carburetted hydrogen, water would, of course, be formed; probably, large quantities of sulphuret of carbon; some sulphuretted hydrogen; and a mixture of sulphur and charcoal, the deposition of which, must be provided for, in a cool place near the furnace, and out of the access of the atmospheric air. With the condensible substances would also be deposited much metallic arsenic, from the decomposition of the arsenious acid; so that the value of the sulphur would be destroyed, from the state of mixture in which it would necessarily be obtained:—not that I believe any quantity of sulphur could be collected; for, it is evident to me, that the preservation of the draught of the calciners, and the condensation of the sulphur, are perfectly incompatible. If the temperature of the flue be reduced, or any stagnation caused, for the purpose of collecting the sulphur, the draught must necessarily be injured; on the other hand, if the heat is great, and there is a rapid current through the flue, with admission of the atmospheric air; the sulphur, supposing decomposition of the gas has taken place, will again ignite, (and it is well known at how low a temperature it inflames,) and the sulphurous acid gas will be re-formed.

In conclusion, I shall offer some calculations, on the quantity of coal that would be required.

It is stated, in Brande's "Manual of Chemistry," p. 153, that 100 cubic inches of light carburetted hydrogen*,

* It may be proper, here, to remark, that coal-gas is a mixture of two varieties of carburetted hydrogen, with other volatile substances, formed at the same time; differing, in the quantity of reducing matter they contain in equal bulks; the proportion of carbon being twice as

weigh 17,325 grains; therefore, one cubic foot weighs 300 grains. Now, supposing 7,000 feet of gas to be procurable from a chaldron of the best Swansea coal,—which we have found to be the result of the experiments we have made in our gas-work, at Hafod,—7,000 feet of gas will give 300lbs. of carburetted hydrogen, consisting of $\frac{1}{4}$th of its weight of hydrogen, and $\frac{3}{4}$ths of carbon;—300lbs. of carburetted hydrogen, therefore, contain 75 of hydrogen. Now, hydrogen, to be converted into water, takes eight times its weight of oxygen: 75lbs. will thus require 600lbs. of oxygen. If, then, the Cornish ore contains, on an average, 12 per cent. of sulphur; there will be required $1\frac{1}{2}$ tons of hydrogen, to unite with the twelve tons of oxygen, combined with the sulphur, in the state of sulphurous acid; or, 45 chaldrons of coal for every 100 tons of ore smelted. But, supposing the carbon contained in the coal, instead of being deposited, is active in taking away the oxygen from the sulphurous acid, as well as the hydrogen; the 225lbs. of carbon, in the gas from a chaldron of coal, will combine with nearly 300lbs. of oxygen; and the quantity of coal required, would, consequently, be one-third less than is above stated.

These calculations are, however, founded upon impossibilities; as—

First, That the whole of the carbon and hydrogen could be brought into action: whereas, it is obvious, that in applying to practice a chemical operation of this nature, the agent and the substance to be acted upon, cannot be brought into perfect contact with each other; nor, when they do meet, will they at all times, or, indeed, at any time, be in the exact proportions required; so that a considerable portion of the reducing agent, or else of the smoke, must pass off unemployed.

In the second place, It is equally impossible for the two

great in the one variety as in the other; but, as the light hydro-carbonate is the most abundant, and my calculation does not profess to be rigorous, I have considered the whole as that substance.

substances in the coal-gas, to act to the full extent of their powers of decomposition, independent of each other; as, undoubtedly, portions of the carbon would combine with the sulphur, liberated by the hydrogen from the sulphurous acid, and a sulphuret of carbon be formed; which compound is a light and extremely volatile liquid, of a very nauseous odour, and very combustible: whilst, at times, some sulphur and hydrogen would combine together, and form the fœtid gas, sulphuretted hydrogen. Hence, supposing the hydro-carbonous substances to be acting in the most favourable way on the copper-smoke; we should have, as the products,—sulphur, charcoal, sulphuret of carbon, sulphuretted hydrogen, carbonic oxide, carbonic acid, and water; just according to the variable heat in different parts of the place where the action was going on, and to the variation in the proportion of copper-smoke and hydro-carbonous compounds, at different times of stirring and charging, either the ore, or the coal to be distilled.

Thirdly, The calculation, as to the quantity of gas to be obtained from a chaldron of coal, is obviously incorrect; as it is made on a supposition, that as much carburetted hydrogen would be obtained in an open fire, as in iron retorts.

Fourthly, An immense increase in the consumption of gas would be occasioned, by the carbon or hydrogen that would be required to convert the carbonic acid from the first fire, into carbonic oxide; and likewise, to decompose the sulphuric acid which exists, to a considerable extent, in the copper-smoke; and would require one-half more carburetted hydrogen for its decomposition, than the sulphurous acid, on which the foregoing calculations are made.

Whatever my own convictions were, as to the impracticability of applying to the general use of Copper Works, the decomposition, by means of any inflammable substance; still, as the suggestion of trying the hydro-carbonous gas emanated from high authority, I was willing to give it

every possible consideration; and, in referring to it, I have, accordingly, entered much more into detail than I otherwise should have thought it necessary to do. I have, however, the satisfaction to state; that, after a due consideration of the manifold objections urged against its practical application; the suggesters fully concur with me in opinion on this point; as well, also, in the persuasion, *that water is the best, and, indeed, the only agent, that can be applied on a working scale.*

In conclusion, It affords me great pleasure, to introduce the opinion of a gentleman, who deservedly stands so high as a man of science; and who was, in the first instance, named as one of the gentlemen to form the Committee of Judges—Mr. Davies Gilbert. Ill health unfortunately prevented his attending at Swansea; but I am happy to express my great obligations to him, for the readiness with which he has, at all times, afforded me every attention, and rendered me every assistance, in the pursuit of this most interesting inquiry.

In a letter I lately received from him on the subject, he says, "I have read all your papers, printed and in manuscript, with the greatest pleasure and satisfaction. They prove that very considerable benefit may be obtained by the simple, plain, and obvious expedients, of high stacks, long flues, with chambers, and the admission of water; and they equally demonstrate, the utter inapplicability of what might be termed, *laboratory resources,* to the great scale of actual Copper Works.—One may lament the failure of suggestions founded on a correct theory of chemistry, and supported by *minute experiments,* for removing the inconveniences altogether; but I find more reason for rejoicing at your partial success, which greatly exceeds my expectation, and with which in my opinion all ought to be completely satisfied."

"In the construction of new Works, if an elevated piece of ground were near, it seems quite obvious, that

the flues should first ascend, to acquire draught for the furnaces, and then be conducted in an horizontal direction; and receive, if possible, water, in the mode exposing the greatest surface. Where elevated ground is not sufficiently near, I would erect, towards the middle of the Works, a stack of great height, and of very large dimensions, into which should be carried the flues from all the furnaces; those of the calciners, at a comparatively low elevation in the stack; and those of the melting furnaces, considerably higher, being conducted by a proper number of inclined planes."

"By this construction, a draught sufficient for the melting furnaces might be obtained; and the additional rarefaction caused by the high temperature of their elastic products (which need not be purified), in the upper part of the central stack, would act in aid of the calciners, for their draught."

I hope I shall not be considered as overstepping the fair bounds of self-gratulation, in here also introducing the following extracts from the same letter of this distinguished character. "*Laudari a laudato viro*" has ever been held to be the most gratifying: it does, therefore, I confess, afford me the highest satisfaction, to receive the following expression of the approbation of a gentleman, so highly qualified to form an opinion on the subject:—

"The publication of your experiments and observations will not merely direct smelters to the true and only methods for rendering their Works as little inconvenient as possible to other people; but they must, sooner or later, moderate public expectation, and induce the nation to tolerate one great source of its power, and of its prosperity; a source, from whence tens of thousands of its most industrious members derive their subsistence; at the price of a small local and unavoidable inconvenience.

"I can only add, that in my opinion, yourself individually, and Vivian and Sons collectively, are deserving of

the utmost praise and thanks, for the ability, the pains, and the expense bestowed on these most interesting experiments."

Borough of Swansea, in the County of Glamorgan.

At a Hall-day, held for the said Borough, on Friday the 7th day of March, 1823, in the Guildhall of the said Borough, before WILLIAM GROVE, Esquire, Portreeve, pursuant to notice duly given:

RESOLVED,

That it is the opinion of this Corporation, that the prosperity and welfare of the town of Swansea and its neighbourhood is mainly supported by the extent to which the Copper Works, situated near this town, are carried on; and this Corporation think it right, to take the present opportunity to express the high satisfaction they feel, at the success that has attended the spirited and scientific exertions of Messrs. Vivian and Sons, in counteracting any inconvenience, that may have at any time arisen to any individuals, from the great issue of smoke from the furnaces in use in the different copper works.

That copies of this Resolution be sent to Messrs. Vivian and Sons; and that the Committee of subscribers to the Fund for obviating the injurious effects of copper-smoke, be requested to annex this Resolution to their Proceedings, now under publication: and that, for this purpose, a copy be also sent to their Secretary.

REFERENCES TO PLATE I.

FIG. 1.

Plan and Sections of the Horizontal Flue, and Condensing Chamber; with Jets of Water, as applied in July, 1821.

A. Plan, or horizontal section of the chamber.

B. Vertical section of ditto.

C. Cross section of the chamber, through *a b.*

D. Cross section of the flue, through *a b.*

E. Cross section of the flue, through *d d.*

a. Pipes in the flue and chamber, with holes for the jets.

b. Iron plates, for the water to strike against.

c. A bridge in the chamber, with holes in the bottom of it, for the water to pass through.

d. A syphon for the discharge of the water, with a bonnet, to be taken off, in order to wash out the sediment.

e. Main water pipes from the canal, which supply the branch-pipes *a*.

f. Brass cocks to ditto, to regulate the supply of water.

FIG. 2.

Plan and Section of the Shower Chambers, with Vertical Divisions, the Smoke ascending and descending as in operation in the summer of 1822; *with Sulphuric Acid Apparatus, Experimental Furnace for Carbonaceous Matters; and Lime-water Vessel.*

F. Horizontal section.

G. Vertical section, shewing the upper horizontal flue from the melting furnaces.

H. Cross section of the chamber, and upper flue.

I. Vertical section of the experimental furnace.

Details of the Shower Chambers.

g. Horizontal flue from the melting furnaces. It was, at first, intended to have carried the flue in a straight line to the stack, as shewn by the dotted lines in the section; but, on consideration, it was thought more prudent to connect it with the calciner flue; lest the stack, being built on a bad foundation, should be injured by breaking another opening into it.

h. Horizontal flue from the calciners, about 4 feet high, by 3 feet 3 inches wide.

i. Pipes, to convey the water to the shower troughs.

j. Brick partitions in the chambers.

k. Shower troughs, supported upon bars of iron.

l. Openings, with iron doors, for passing the troughs in and out, and superintending the operations. The lower openings in the side of the chamber, are for observing the shower.

m. Openings in the bottoms of the partitions, for the passage of the smoke.

n. Discharging pipes for the water; the mouths kept covered in the trough, *o*, to prevent the admission of air.

p. Iron damper in the main flue, made to turn on its centre.

q. Flue from the metal calciners.

LIME-WATER EXPERIMENT.

r. Lime vessel.

s. Tube for conveying the lime-water to the shower troughs.

SULPHURIC ACID APPARATUS.

t. Small flue leading to the leaden chamber.

u. Furnace for preparing the nitrous gas.

v. Chamber of lead.

w. Small flue conducting to the main flue, from the leaden chamber.

EXPERIMENTAL FURNACE.

x. Small flue leading to the furnace, furnished with a damper at *y*.

z. Body of the furnace, about four feet square.

a'. Flue from the furnace to the chimney, *b'*.

c'. Fire-door.

FIG. 3.

General Plan and Section of the Horizontal Flue from the Calciners, the Shower Chambers with Divisions (the Smoke traversing horizontally), High Stack, and Melting Furnace; as in operation in November 1822.

J. Vertical section.

K. Horizontal section.

L. Cross section of the chamber.

The Details of the Chamber, as in Fig. 2.

d'. Opening in the end of the partition, for the smoke to traverse the chamber horizontally.

e'. Reverberatory furnace, drawing into the high stack *f'*, through the flue *g'*, used for melting slags.

M. Section of the first shower-chamber on the metal calciner flue, as at work in November 1822.

q'. Horizontal flue from the metal calciners.

i'. Brick partition.

j'. Opening in the upper part of the partition, for the passage of the smoke.

k'. Copper cistern for showers.

l'. Water pipes to supply the cistern.

[*To be continued.*]

XII.—*Description of Mr.* PERKINS's *New Steam-Engine, and of the Application of his Invention to Engines of the old Construction.*

WITH A PLATE.

WE have already communicated to our readers all the authentic information which we could obtain respecting Mr. Perkins's new Steam-Engine; and we have used the utmost diligence to obtain such further information as may, in some measure, gratify that curiosity which these imperfect notices have excited. There never has been in our day an invention which has created such a sensation in the scientific and in the manufacturing world. The Steam-Engine of Mr. Watt, had been so long considered as the greatest triumph of art and science, that it was deemed a sort of heresy to regard it as capable of improvement; and notwithstanding all that has been done by Mr. Woolf, and other eminent engineers, the undoubted merit of their engines has scarcely yet been admitted by the public. Under such circumstances, Mr. Perkins's claims were likely to meet with various kinds of opposition. Instead of hailing it as an invention, which was to do honour to the age in

which we live, and to add a new and powerful arm to British industry; imperfect experiments and confined views were urged against the principle of its construction,—the jealousies of rival traders were arrayed against it,—imaginary apprehensions of danger were excited,—and short-sighted politicians sounded the alarm, that such an invention would precipitate our country from its lofty pre-eminence among the manufacturing nations of the world.

Most of these grounds of opposition have been now removed by direct experiment. Mr. Perkins's engine is actually at work. Its operations have been witnessed, and minutely examined, by engineers and philosophers of all kinds; and the most unreasonable sceptics have been compelled to acknowledge the justness of its principles, as well as the energy of its operations. Mr. Perkins, however, did not remain satisfied with this experiment. He has discovered a method, which we consider equal in value to his new engine, by which he can convey the benefit of his original principle, to steam-engines of the old construction; and this has been recently succeeded, we are told, by a most extraordinary discovery,—that the same heat may be made to perform its part more than once, in the active operations of the engine.

The generator, which supplies the place of the boiler in ordinary steam-engines, is a cylinder made of gun-metal, which is more tenacious, and less liable to oxidation than any other. The metal is about three inches thick; and the vessel, containing eight gallons of water, is closed at both ends, with the exception of five openings for tubes. The generator is placed vertically in a cylindrical furnace, the heat being sustained by a pair of bellows worked by the engine. A heat from 400° to 500° of Fahrenheit is thus applied to the generator, which is entirely filled with water. The valves are steel cylinders working in steel pipes, and are loaded, the one with 37 and the other with 35 atmospheres; so that none of them can rise, till the heat creates a force greater than the least of these weights.

Let us now suppose, that by means of a compressing pump, whose handle is worked by the engine, water is forced into the generator: this opens a valve loaded with 35 atmospheres, and instantly a portion of the heated and compressed water *flashes* out, in the form of steam, of high elasticity, and of a temperature of 420°; and communicating by a steam-pipe with a rotary valve, it enters the cylinder lying horizontally, and gives motion to its piston, which performs 200 strokes in a minute, and drives a crank, which gives a rotary motion to a fly-wheel. The piston-rod is connected, by a flexible joint, with a sort of carriage, with four wheels at each end, and working in a strong horizontal box of steel. When the eduction-valve is opened, the steam, after having produced its stroke, is carried by the eduction pipe into the condenser, where it is condensed into water, at a temperature of about 320°, and under a pressure of 5 atmospheres: from thence, by another pipe it is drawn again into the pump, from whence it is forced into the generator; thus performing a complete circuit.

The forcing-pump acts with a pressure exceeding 35 atmospheres; consequently, when the water received into it from the condenser is urged into the generator, it must expel a portion equal to itself in volume: this portion, as above described, flashes instantly into highly elastic steam. The forcing-pump, too, is so contrived as to act with a steady force; and consequently, the expelled water must be driven from the generator in a steady current: and thus steam, of a constant elasticity, is supplied to produce the power.

Some philosophers are of opinion, that the heat of the portion of water which escapes, is, of itself, sufficient to maintain the steam at that high degree of heat and elasticity with which it reaches the piston; and, consequently, that this engine is nothing more than a High-Pressure Engine. Other persons, however, have supposed, (and we confess we are among that number,) that the portion of water

which escapes, must necessarily carry off a quantity of heat, from the adjoining stratum (the temperature of which *may be* thus reduced below the freezing point). But it is more likely, that, in virtue of some new law, of the transmission of heat, under the combined conditions of elevated temperature and high pressure; while the water, also, is forced to remain in contact with the red-hot generator; the whole water in the boiler may be laid under requisition, to furnish the discharged fluid with its necessary supply of caloric.

It is almost unnecessary to state, that the motion of the engine is produced by the difference in elasticity, between the steam pressing on one side of the piston, and that on the other. In the first case, the steam recently produced acts with a force, say of 500lbs. on the square inch; while that on the weak side, or that communicating with the condenser, acts only with 430lbs., the difference, or 70lbs., being the true power gained.

When there is a surplus of water in the generator, occasioned either by working the forcing-pump too violently or by too vehement a heat; the water will escape by a tube, with a valve above, loaded with 37 atmospheres, and will pass into the condenser.

From the high elasticity of the steam employed in this engine, it has been supposed to be very liable to explosion. This, however, is a vulgar error: since there is no reservoir of steam, exposing a large surface to its expansive force, as in the common high pressure engines—the steam being generated only in sufficient quantity to produce each succeeding stroke of the piston, the ordinary source of danger is entirely removed. But, in order to take away all apprehensions on that subject, the eduction-pipe, in which the steam is actually formed, is made so strong, as to sustain an internal force of *four thousand* pounds on the square inch, which is *eight* times more powerful than the actual pressure, viz. 500 pounds on the square inch, with which the engine works. This enormous superabundance

of strength is still further secured, by means of a pipe, provided with a thin copper "*safety-bulb*", which is made so as to burst at a pressure of 1000 pounds on the square inch. In order to satisfy his friends on this very important point, Mr. Perkins has repeatedly urged the power of the steam to such a degree, as to burst the copper bulb in their presence. This merely rends, or is torn asunder, like a piece of paper, and occasions no injury, either to the spectators or to the apparatus; so that we have no hesitation in considering this engine, notwithstanding its tremendous energies, much more safe in its operations, than even the common low-pressure engine.

The safety-tube communicates also with an indicator, having a dial-plate and an index, which, by means of a suitable contrivance, indicates the pressure or number of atmospheres with which the engine is working.

The engine which we have now described, is at present performing actual work in Mr. Perkins's manufactory. It is calculated as equal to a ten-horse power, though the cylinder is no more than two inches in diameter, and eighteen inches long, with a stroke of only twelve inches. Although the space occupied by the engine is not greater than six feet by eight; yet Mr. Perkins considers that the apparatus (with the exception of the working cylinder and piston), is perfectly sufficient for a thirty-horse engine. When the engine performs full work, it consumes only *two* bushels of coal in the day.

On the Application of Mr. Perkins's Principle to Steam-Engines of the old Construction.

Great as the invention is which we have now described, yet we are disposed to think, that the application of the principle to old steam-engines, is not less important *. When we consider the enormous capital, which is at present embodied in Great Britain, in the substantial form of

* This invention appears to have been fully established by direct experiment; whereas the *new engine*, with all its great promise, is still undergoing a trial.

steam-engines; and the admirable elegance and skill with which these noble engines impel and regulate the vast population of wheels and pinions over which they reign; we feel as if some vast innovation were proposed upon our established usages, by the introduction of Mr. Perkins's engine. The very idea, that these potentates of the mechanical world, should be displaced from their thrones; that their strong-holds should be dismantled; their palaces demolished, and their whole affairs placed under a more economical management; is something startling to those who dread a change, and admire institutions that both work and wear well. Mr. Perkins, however, has saved them from such a degradation. He has allowed them to retain all their honours and privileges, and proposes only to invigorate them with fresh influence and power.

In this new system, the old engines, with their boilers, are retained unaltered:—the furnaces alone are removed. Mr. Perkins constructs a generator, consisting of three horizontal tubes of gun-metal connected together, filled with water, and supplied with water from a forcing-pump, as in his own engine. This generator is exposed to heat, in an analogous manner; so that, by means of a loaded valve, which opens and shuts, the red-hot fluid may be constrained, till forced out of the generator into the water in the boilers of Boulton and Watt. By this means, as much low-pressure steam, of four pounds on the square inch, may be generated by *one* bushel of coals, as could be produced in the old engine by *nine* bushels. This most important result was obtained by actual experiment.

Since these great improvements have been effected, Mr. Perkins has made a discovery, that seems, in its practical importance, to surpass them all. He now entirely dispenses with the use of the condenser, and works the engine against the atmosphere alone: and by methods with which we are not acquainted, and which, indeed, it would not be prudent for him to disclose at present, he is enabled *to*

arrest the heat, after it has performed its mechanical functions; and actually pump it back to the generator, to unite it with a fresh portion of water; and renew its useful labours. In an operation like this, a considerable portion of the heat must still be lost; but the wonder is, that any should be saved: and we venture to say, that the most sanguine speculator on the omnipotence of the steam-engine, never dared even to imagine the possibility of such an invention.

We are well aware, that, in announcing this discovery, we are exposing ourselves to the criticisms of those whose belief is naturally limited by their own experience: but it is satisfactory to know, that Captain Basil Hall, (whose account of Mr. Perkins's discoveries and inventions, as delivered before the Royal Society of Edinburgh, gave such universal satisfaction,) has been intrusted with Mr. Perkins's discovery, and that he speaks confidently of the soundness of its principles, as well as the practicability of its application.

We cannot quit this subject, without congratulating the country on the brilliant prospects with which these inventions promise to invest all our national concerns. At any period of the history of British industry, they must have excited the highest expectations; but, originating as they have done, when our commerce, our manufactures, and our agriculture,—the three stars of our national prosperity,—have just passed the lowest point of their orbit; and quitted, we trust for long, the scene of their disturbing forces; we cannot but hail them with the liveliest enthusiasm, and regard them as contributing to ensure the pre-eminence of our industry, to augment the wealth and resources of the nation, and, by giving employment to idle hands, to secure the integrity and the permanence of our national institutions.

It is due to the truth and candour of philosophical history, to mention, that Mr. Perkins is not our countryman: but the age of jealousy against America has happily gone

out; and we hail, with sincere pleasure, any circumstance which contributes to the scientific renown of our great descendants, and companions in freedom and intelligence.

We have extracted the above from the Edinburgh Quarterly Philosophical Journal, just published; but, as the specification of Mr. Perkins's first patent for his improvements in Steam-Engines is now enrolled; we shall likewise add the following extracts from it, with other particulars, for the information of our readers: —

"The improvements consist in heating water, or other fluid, for the purpose of generating steam in vessels kept perfectly full, and under pressure, which vessels are proposed to be substituted for the ordinary boilers of steam-engines, and are called GENERATORS: By this contrivance, a sufficient quantity of steam may be generated, for working an engine of any given power, with a much smaller quantity of fuel, than would be necessary, if the ordinary construction of boilers were employed. The improvements likewise extend, to the causing of portions of such heated water, or other fluid, to escape from under the pressure, and to pass from the generator into the steam-pipe, where it instantly becomes steam, and proceeds directly to the cylinder, without the intervention of a steam-chamber. And, further, the improvements embrace the mode, whereby such heated water, or other fluid, is to be displaced from the generator; which is done by forcing a corresponding quantity of water into the generator, its uniform volume being maintained under a certain pressure. Lastly, the improvements contemplate the employment of the above principles, for the purpose of generating steam for the working steam-engines generally; whether such steam be employed to act through the steam-pipe, directly upon the piston; or to supply a steam-chamber, for the same purpose."

"I do hereby describe a manner in which my said invention may be performed; which manner is the best I

described, having the furnaces *y*, *y*, under them; *b*, is the escape-valve, through which the heated water passes; *c*, is the weighted lever, pressing down the valve with the required force: *d*, is the chamber and pipe, in which the heated water that escapes through the valve becomes steam, and thence passes through the tube *z*, into the boiler. This boiler (of a cylindrical form, with hemispherical ends) is proposed to be enclosed within a cask or other vessel, and surrounded with powdered charcoal, which material, being a very imperfect conductor of heat, is particularly well calculated to preserve the heat of the water and steam, within the boiler; *e*, is a pipe leading from the generator, which is also filled with the heated water; and at the lower end of this pipe, there is an apparatus *f*, for ascertaining the pressure of the fluid within the generator. This fluid, by exerting its force at the lower end of the pipe *e*, against a lever, connected with a weighing-machine, causes the index to point out upon the graduated dial-plate, the number of atmospheres under which the steam is generated. The pipe *e*, being in substance considerably thinner than any other part of the apparatus, is intended to give way, in the event of the pressure within the generator being accidentally raised to a dangerous height; the consequence of which would be, that the pipe *e*, would open, and the steam blow out through the fissure, without the possibility of producing any injury; *g*, is the pipe through which the water is injected by the pump *h*, from the reservoir to the generator; *i*, represents the flue or chimney, from the furnace below.

"The continued passage of high-pressure steam (generated as above), through the tube *z*, heats the water, which occupies about half the interior of the boiler; and, by that means, a sufficient quantity of steam may be produced in the boiler, for working an engine of the ordinary construction; and with a very important saving in the quantity of fuel, compared to what would be consumed, to effect the same purpose, by any other means heretofore adopted."

"Now whereas the materials of which my said improve-

ments are constructed, and the exact proportions of the relative parts of my said improvements, are not subjects for which I hereby claim exclusive privilege, though I have described those materials and proportions which I have found most useful; neither do I hereby claim exclusive privilege for the peculiar forms of the various mechanical agents which I employ; but only for a combination of such and the like agents, as will produce the said improvements, the nature of which is herein before declared, and for which a claim to exclusive privilege is hereinafter made. And whereas, I have only represented in my said drawings annexed, such parts of a steam-engine as comprise my said improvements; the various modes of applying such said improvements, by means of the steam-pipe, being too well known to require particular description here. And whereas, my said generator may be heated by a variety of known furnaces, therefore I have not described any one in particular; but the one I have used, and found to be the best, is one of the cupola kind, fed by a blast. And whereas, I have described in my said drawing, fig. 1, a safety-pipe and indicator, and a forcing-pump, neither of which are in themselves new; but which apparatuses, or similar ones, constitute a combination necessary to my said improvements, and are inserted here as such; I therefore hereby claim exclusive privilege for the following improvements only: *that is to say*, *First*—For heating water, or other fluid or fluids, for the purpose of generating steam for steam-engines, in a vessel or vessels kept (during such process of heating) full of such water, or other fluid or fluids, and under a pressure greater than the expansive force of the steam to be generated from such water, or other fluid or fluids, at the time of its generation.

"*Secondly*—For causing such water, or other fluid or fluids, so heated as aforesaid, to escape from under the said pressure, and pass at once from the generator into the steam-pipe, where it becomes steam or vapour; and in that form may pass thence to the cylinder, or to any other situ-

ation connected with a steam-engine, without the necessary intervention of any steam-chamber, or other reservoir of steam.

"*Thirdly*—For the manner of causing such water, or other fluid or fluids, to escape as aforesaid; that is to say, by forcing other water, or other fluid or fluids, into the generator, until the pressure against the steam-valve shall cause it to rise; the valve being so loaded as not to rise, except by means of such extra pressure, as aforesaid.

"*Fourthly*—For the general application of such water, or other fluid or fluids, so heated as aforesaid, and of the steam or vapour generated thereby; whether such steam or vapour be employed through a steam-pipe, without a steam-chamber or reservoir, to act immediately on the piston; or to be collected in a reservoir or steam-chamber, and thence to act on the piston; or only for heating water to generate other steam, or for any other purpose or purposes whatsoever; provided always, that such general application as aforesaid, be for the purposes of steam-engines. *All of which said improvements* are, to the best of my knowledge and belief, entirely new, and have never before been practised in these kingdoms."

XIII.—*On the Causes of the great Superiority of the Limerick Fish-Hooks. By the* EDITOR.

WITH FIGURES.

IN our last Number, p. 67, we promised to afford our readers further particulars on this subject.

Sir Thomas Frankland, Bart. (whose scientific acquirements are too well known and acknowledged, to need any eulogium on our part,) in the year 1810, favoured us with the following particulars of this manufacture.

He stated that the Limerick fish-hooks were highly esteemed by anglers, for salmon-fishing, &c.; and that they were made of cast-steel, forged square by nailers, with solid wedge-shaped pieces at the end of each, out of which the barbs were to be formed by filing; the shanks

were then filed round; and after being bent to the required curve, they were carefully hardened and tempered, by being laid upon a plate of iron, and heated, until a drop or two of tallow let fall upon the plate smoked or blazed; and which pointed out the proper tempering heat, according to the quality of the steel employed.

Sir Thomas attributed the chief cause of the failure in the barbs of the English hooks, to *their being cut with a knife*, instead of being *filed out of the solid*;—and in this opinion we entirely agree with him.

In Plate II. fig. 4., we have given a magnified representation of one of the real Limerick hooks, sent us by our worthy correspondent A. M.; and in which it will be seen that the barb is really filed out of the solid, from a piece of steel shaped like fig. 5. and agreeable to our information from Sir Thomas Frankland. Whereas the English hooks are first cut with a knife, in the manner shown in fig. 6., so as to make a very deep indentation in the wire; and the barbs are filed to the proper shape afterwards.

On examining some of the London Limerick-hooks, as they are called, with a microscope; we found, that although they had given to the barbs, a shape somewhat resembling the real Limerick ones; yet that in fact they had first cut them with the knife, in the usual manner of making the English hooks; and which we have ourselves seen done by women, with a very coarse instrument, at Redditch, near Bromsgrove, in Worcestershire; (this is the chief seat of the needle and fish-hook manufactures in this country). It cannot therefore (and especially after the previous long annealing of the wire, mentioned in our former Article) be any longer a matter of wonder, that the Limerick hooks should so greatly exceed the English ones in their strength. The remedy, however, is in our own hands; and although, doubtless, an additional expense would be incurred, from the adoption of the Limerick practice; yet that would be cheerfully complied with, by those anglers who wish not to bestow their time and pains in making artificial flies upon hooks, so very insufficient, as the English ones are found to be.

One specimen of the Limerick hooks, sent by our correspondent, is made of *shear-steel;* and though not so neatly finished as the *cast-steel* ones, is, no doubt, a very serviceable one;—and we found, that all those made in imitation of them, by our correspondent, had *their barbs filed out of the solid wire,* and not *cut* like the English ones; so that even though some of them were, as he states, *merely formed of iron wire, case-hardened;* we have no doubt of their great superiority, over those usually made in this country of steel wire.

We presume, that the wire had been spread at one end, by hammering it, before shaping the barb with files.

XIV.—*On the perfect Refining or Toughening of Copper. By the late* W. E. SHEFFIELD, *Esq.*

IN our First Volume, p. 97, we promised to afford our readers some information on the process for *rendering copper sufficiently malleable to be beaten into Dutch-leaf; and, when united with pure zinc, to afford a fine brass, equally malleable, ductile and durable, as the best foreign brass.*

We were not aware, until perusing the account of the method of refining copper in this country, by Messrs. Vivian (and which we have given in our last Volume), *how exceedingly imperfect the process of poling it in the reverberatory melting furnace is, and how utterly inadequate it is to give copper that degree of malleability and toughness, which, by a better process, it is capable of receiving.*

Notwithstanding the great improvement their calcining, melting, and refining furnaces have received, from the adoption of the late Mr. Sheffield's patent *air-conductors;* yet, still, they are utterly unfit for the purpose of refining or toughening the copper.

It is impossible to effect this object in the reverberatory furnace; as it requires the exclusion of the atmospheric air, the *oxygen* of which acts upon the metal, in a directly contrary manner to the *carbon;* which, by covering it with charcoal, and stirring or *poling* it, is intended to be employed in toughening it.

The process is as follows:—The copper, in the purest

state it is to be met with, is either to be granulated, or made into plates of a moderate thickness: it must then *be cemented with charcoal in closed vessels;* and be kept heated, in a proper furnace, at a temperature a little below that which would fuse the copper, until, upon examination, the surface of it is found to be covered with a very peculiar granulation or crystallization.

The Dutch coppet for sheathing vessels is found to endure the action of the salt-water for a much longer time than English copper; most likely, owing to its having been subjected to this process.

Mr. Sheffield obtained a patent for the exclusive use of this process, in this country, a few years since;—which has yet several years to run. We mention this, on observing that a patent was taken out, in June last, for improving copper for sheathing ships, &c.

XV.—*Description of the Great Bandana Gallery, in the Turkey-Red Factory of Messrs.* MONTEITH *and Co. at Glasgow.* *

WITH A PLATE.

THE benefits of liberal-mindedness are nowhere more fully displayed than in the modern advancement of our chemical arts. A quarter of a century ago, manufacturing chemists were wont to shroud their operations in mysterious secrecy, like the craftsmen of the dark ages; on a supposition, usually unfounded, of their being possessed of some wonder-working *recipes,* whose promulgation would be fatal to their interests. At that period, the moneyed proprietors of chemical factories were rarely practical chemists. They were, therefore, obliged to place entire dependence in certain operative adepts, whom they engaged, at a considerable salary, to conduct their processes. These persons, having been previously employed as subordinate menials in some similar manufactory, had acquired a smattering notion of the routine of working; but, being entirely destitute of

* From the Quarterly Journal of Science, &c.

education, and having no general views concerning the business which they undertook to manage, they were perpetually falling into difficulties, and committing mistakes from time to time of the most ruinous description. Slight variations in the qualities and state of the materials employed, in the mode of mixture, in the temperature, or duration of the process, occasioned variations of result, which they could neither foresee, regulate, nor counteract; and, though the profits might be considerable on a successful operation, yet failures were so frequent and so expensive as to render the business not a little precarious and uncomfortable. Hence we can understand why chemical manufactories have undergone such vicissitudes of fortune,—some raising their proprietors to unexpected opulence, others sinking them to unlooked-for ruin.

The owners of chemical establishments, becoming at length impatient of the vassalage in which they had been long held by blundering and obstinate hirelings, began to inquire into the principles of their peculiar arts, and were thus led to cultivate the society of men of science. They now for the first time, learned, that economy and precision could be ensured to their processes, only, by applying the same scientific rules which medical censorship, backed by the authority of law, had for a considerable time introduced with the happiest effect into the formerly mysterious and uncertain processes of pharmacy. Under this conviction, they consulted the chemical philosopher on their difficulties and disappointments. Suggestions, of greater or less value, were thus given and acted on, which led to new questions on the part of the manufacturer, and new researches on that of the chemist: and thus an alliance began between theory and practice, which has, in a very few years, carried several of the chemical arts of this country to an extraordinary pitch of perfection.

Instances have, undoubtedly, occurred of chemists of some reputation having given delusive advice to the manufacturer; as we see chemical authors publish, as processes

of art, formulæ very disadvantageous, and even absurd. These misdirections are almost always to be ascribed either to neglect of experimenting with due care on an adequate scale, or to superficial acquaintance with the principles of the science. It is very possible for a person to compile a dazzling series of class experiments with grandiloquent explications, without being either a philosophical or a practical chemist.

The league between Science and Art, which has in this country been the slow growth of necessity, was long ago effected in France, to a considerable extent, by authority of the Government. The illustrious minister, Colbert, fraught with the most enlightened views of state policy, founded a school of science to superintend and assist the dyeing manufactories of the kingdom. From that school, conducted as it has been by a succession of eminent philosophers, have emanated invaluable researches on the most beautiful, but, at the same time, most intricate, of all the chemical arts,—researches to which France owes much of her eminence in this very profitable branch of her national industry.

The manufactory of Messrs. Monteith and Co. has been long celebrated in the commercial world for the excellence and beauty of its cotton fabrics. The madder-reds rival in brilliancy and solidity any ever produced at Adrianople; and the white figures distributed over the cloth surpass, in purity, elegance, and precision of outline, the original Bandana designs.

The opulent and enlightened proprietors have been careful to avail themselves of every resource which the latest improvements in chemistry and mechanics could supply. In this respect, their factory deserves to be studied, as a school of practical science. The permission now granted of describing their discharging-gallery is a proof of their liberality; as well as of the confidence, justly entertained, that the capital and skill now engaged in their establishment are better securities for the preference which their

goods possess in the European market, than the utmost mystery in conducting their processes. Hence they have rarely refused to strangers, respectable for their rank or science, permission to visit their manufactory,—a favour which it is impossible to enjoy without being gratified and instructed.

Their new arrangement of hydrostatic presses was completed in 1818, under the direction of Mr. George Ridger, senior, manager of the works. It consists of sixteen of these engines, beautifully constructed, placed in one range, in subdivisions of four; the spaces between each set serving as passages to admit the workmen readily to the back of the press. Each subdivision occupies twenty-five feet; whence the total length of the apparatus is one hundred feet.

To each press is attached a pair of patterns, in lead, (or *plates* as they are called,) the manner of forming which will be described in the sequel. One of these plates is fixed to the upper block of the press. This block is so contrived, that it turns on a kind of universal joint, which enables this plate to apply more exactly to the under plate. The latter rests on the moveable part of the press, commonly called the *sill*. When this is forced up, the two patterns close on each other very nicely, by means of guide-pins at the corners, fitted with the utmost care.

The power which impels this great hydrostatic range is placed in a separate apartment, called the *machinery room*. This machinery consists of two cylinders of a peculiar construction, having cylindric pistons accurately fitted to them. To each of these cylinders three little force-pumps, worked by a steam-engine, are connected.

The piston of the larger cylinder is eight inches in diameter, and is loaded with a top-weight of five tons. This piston can be made to rise about two feet, through a leather stuffing or collar. The other cylinder has a piston of only one inch in diameter, which is also loaded with a top-weight of five tons. It is capable, like the other, of being raised two feet through its collar.

Supposing the pistons to be at their lowest point, four of the six small force-pumps are put in action by the steam-engine; two of them to raise the large piston, and two the little one. In a short time, so much water is injected into the cylinders, that the loaded pistons have arrived at their highest points. They are now ready for working the hydrostatic discharge-presses; the water pressure being conveyed from the one apartment to the other under ground, through strong copper tubes of small calibre.

Two valves are attached to each press; one opening a communication between the large *prime-cylinder* and the cylinder of the press, the other between the small *prime-cylinder* and the press. The function of the first is simply to lift the under-block of the press into contact with the upper-block; that of the second is, to give the requisite compression to the cloth. A third valve is attached to the press, for the purpose of discharging the water from its cylinder, when the press is to be relaxed, in order to remove or draw through the cloth.

From twelve to fourteen pieces of cloth, previously dyed Turkey-red, are stretched over each other, as parallel as possible, by a particular machine. These parallel layers are then rolled round a wooden cylinder, called, by the workmen, a drum. This cylinder is now placed, in its proper situation, at the back of the press. A portion of the fourteen layers of cloth, equal to the area of the plates, is next drawn through between them, by hooks attached to the two corners of the webs. On opening the valve connected with the eight-inch *prime-cylinder*, the water enters the cylinder of the press, and instantly lifts its lower block, so as to apply the under plate, with its cloth, close to the upper one. This valve is then shut, and the other is opened. The pressure of five tons in the one-inch *prime-cylinder* is now brought to bear on the piston of the press, which is eight inches in diameter. The effective force here will, therefore, be 5 tons $\times$ 8^2 = 320 tons; the areas of cylinders being to each other as the squares of their respec-

tive diameters. The cloth is, therefore, condensed between the leaden pattern-plates, with a pressure of 320 tons.

The next step is, to admit the blanching or discharging liquor (aqueous chlorine, obtained by adding sulphuric acid to solution of chloride of lime) to the cloth. This liquor is contained in a large cistern in an adjoining house, from which it is run, at pleasure, into small lead cisterns attached to the presses; which cisterns have graduated index-tubes, for regulating the quantity of liquor according to the pattern of discharge. The stop-cocks on the pipes and cisterns containing this liquor are all made of glass.

From the measure-cistern, the liquor is allowed to flow into the hollows in the upper lead-plate, whence it descends on the cloth, and percolates through it, extracting, in its passage, the Turkey-red dye. The liquor is finally conveyed into the waste pipe, from a groove in the under block. As soon as the chlorine liquor has passed through, water is admitted, in a similar manner, to wash away the chlorine; otherwise, on relaxing the pressure, the outline of the figure discharged would become ragged. The passage of the discharge liquor, as well as of the water through the cloth, is occasionally aided by a pneumatic apparatus, or blowing machine; consisting of a large gasometer, from which air, subjected to a moderate pressure, may be allowed to issue, and act, in the direction of the liquids, in the folds of the cloth. By an occasional twist of the air stop-cock, the workman also can ensure the equal distribution of the discharging liquor over the whole excavations in the upper plate. When the demand for goods is pressing, the air apparatus is much employed, as it enables the workman to double his product.

The time requisite for completing the discharging process, in the first press, is sufficient to enable the other three workmen to put the remaining fifteen presses in play. The *discharger* proceeds now from press to press; admits the liquor, the air, and the water; and is followed, at a proper interval, by the assistants, who relax the press, move for-

wards another square of the cloths, and then restore the pressure. Whenever the sixteenth press has been liquored, &c., it is time to open the first press. In this routine, about ten minutes are employed; that is, 224 handkerchiefs (16 × 14) are discharged in ten minutes. The whole cloth is drawn successively forward, to be successively treated in the above method.

When the cloth escapes from the press, it is passed between two rollers in front; from which it falls into a trough of water placed below. It is finally carried off to the washing and bleaching department, where the lustre of both the white and the red is considerably brightened.

By the above arrangement of presses, 1600 pieces, consisting of 12 yards each = 19,200 yards, are converted into Bandanas in the space of ten hours, by the labour of four workmen.

The patterns, or plates, which are put into the presses to determine the white figures on the cloth, are made of lead, in the following way. A trellis frame of cast-iron, one inch thick, with turned-up edges, forming a trough rather larger than the intended lead pattern, is used as the solid ground-work. Into this trough, a lead plate, about one half inch thick, is firmly put, by screw nails passing up from below. To the edges of this lead plate, the borders of the piece of sheet-lead are soldered, which covers the whole outer surface of the iron frame. Thus a strong trough is formed, one inch deep. The upright border gives at once great strength to the plate, and serves to confine the liquor. A thin sheet of lead is now laid on the thick lead-plate, in the manner of a veneer on toilette-tables, and is soldered to it, round the edges. Both sheets must be made very smooth beforehand, by hammering them on a smooth stone table, and then finishing with a plane: the surface of the thin sheet (now attached) is to be covered with drawing-paper, pasted on; and upon this, the pattern is drawn. It is now ready for the cutter. The first thing which he does, is to fix down, with brass pins, all the parts of

the pattern, which are to be left solid. He now proceeds with the little tools generally used by block-cutters, which are fitted to the different curvatures of the pattern; and he cuts perpendicularly, quite through the thin sheet. The pieces thus detached are easily lifted out; and thus the channels are formed, which design the white figures on the red cloth. At the bottom of the channels, a sufficient number of small perforations are made through the thicker sheet of lead, so that the discharging liquor may have free ingress and egress. Thus, one plate is finished; from which an impression is to be taken, by means of printers' ink, on the paper pasted on another plate:—the impression is taken in the hydrostatic press. Each pair of plates constitutes a set, which may be put into the presses, and removed at pleasure.

Plate III. is an elevation of one press; A, the top or entablature; BB, cheeks of ditto, or pillars; C, upper block for fastening upper pattern to; D, lower or moveable block; E, the cylinder; F, the sole or base; G, the water-trough for the discharged cloth to fall into; aa, tubes to admit water; b, tube for air; c, cock to admit liquor from the metre; H, cistern, or liquor-metre; dd, glass tubes for indicating the quantity of liquor in the cistern; ee, glass stop-cocks for admitting the liquor into the cistern; ff, stop-cocks for admitting water; gg, the pattern-plates; nn, screws for setting the patterns parallel to each other; mm, *muffs* perforated with a half-inch drill. The lower iron frame has corresponding pins which suit these perforations, so that the patterns are guided into exact correspondence with each other; hh, rollers which receive and pull through the discharged cloth, from which it falls into the water-box; k, stop-cock for filling the trough with water; iii, waste tubes for water and liquor.

Glasgow, May 30th, 1823.

Remarks on the preceding Article.

It may be interesting to our Readers, to trace the progress of the different methods of producing spots or figures

on silk or cotton handkerchiefs, down to the above great improvement thereon. We remember the time when the dyers were in the practice of employing numbers of women and children, to gather, and tie up, little square parts of the undyed cloth, in regularly arranged figures, which prevented the dye from penetrating those parts; and thus, white or yellow square spots were produced over the surface of the handkerchief. The next stage, and which was indeed a very considerable improvement on the foregoing process, was the introduction of the method of discharging the colours;—which we find described in Rees's New Cyclopœdia, under the Article "*Discharging.*" We shall make the following extract:—

"This process is frequently employed, by dyers, to produce particular patterns upon the dyed stuffs. A manufacture of this kind has lately been introduced, and prosecuted to great extent, in the West of Scotland, for the purpose of manufacturing Bandana handkerchiefs, in imitation of those imported from India. The material of which the fabric consists is cotton; and the cloth is sometimes tweeled, and sometimes woven plain. The ground of the handkerchief is generally of the fast dye, commonly known by the appellation of Turkey-red; and this colour being afterwards discharged in particular places, a number of white spots are interspersed upon the red ground. The process is by no means complex; but as the manufacture is recent, has hitherto been chiefly if not entirely confined to the district where it originated, and has been much admired, an account of the engine employed, and of the process, may, perhaps, deserve some attention. In the Indian Bandanas, the white spots are generally placed in clusters, in the diagonal or diamond direction; and this distribution has been most frequently adhered to in the imitation handkerchiefs. The spots are sometimes round, sometimes square, and sometimes, though more rarely, triangular. Previous to the discovery and introduction of the discharging process, as applied to this manufacture, many imitations of the

Bandanas had been made by the common mode of calico-printing. But the colours of the printed handkerchiefs, besides being less brilliant at first, were found to fade so soon, that the discharged ones do already, in a great measure, and will probably very soon entirely, supersede them.

"The engine employed is a very strong screw-press, the whole framing of which is generally of cast-iron. In constructing this press, it is absolutely necessary that every part should be so strong, as to bear a very great pressure, without yielding any where.

"The pattern to be formed is cut upon two flat plates, which exactly correspond. They are usually of cast-iron; and the lower plate is faced with copper, or some metal which will both receive a fine polish, and resist, to a great degree, the corrosive power of the discharging liquor, which is composed of a preparation of the oxymuriate of lime diluted with water. In the under plate, which must be perfectly smooth and level, a hole is cut for every spot which is to be discharged. In the upper plate, or cover of the press, every spot is formed by a hollow tube of brass or copper; which is tightly driven into a hole formed in the plate, and cemented with a composition of white-lead and oil, or any other cement, which will prevent the discharging liquor from escaping by any other passage than those through the perforated tubes.

"About the upper plate or cover is a rim, to prevent the discharging liquor from running off. At each corner of the plate is a round hole, working upon a pin, fastened in the under plate or sole of the press, to guide the bottoms of the perforated tubes perpendicularly over the holes in the lower plate. Besides these guides, there are two notches, which grasp the upright pillars of the press; and thus the upper plate, when rising and sinking, is guided in six different places. The elevation and depression of the cover is effected by turning the screw of the press; upon which is a wheel with upright spokes around it, through which is put the lever, used for screwing down and

raising the cover, as in other large presses. The sole or bottom of the press is placed exactly in a horizontal position; and is supported by six strong iron perpendicular legs; namely, by one at each corner, and by the lower parts of the two upright pillars of the press, in the middle. Between the cover and the bottom, the cloth to be discharged is placed.

"The mechanical part of this process is, in almost every respect, entirely similar to that used by cloth-dressers, book-binders, and many other tradesmen who employ strong screw-presses. To ensure the accuracy of its operation, correctness of workmanship, and strength, are all that are necessary; and these are indispensable. The press must be so fixed, that both the cover and bottom may be horizontal planes. The bottom must be perfectly level; and the perforated tubes in the cover must all exactly touch the bottom with an equal pressure. The perforations of the tubes must also correspond exactly with the holes or apertures in the bottom; and the guides must be fitted to work freely, but, at the same time, to prevent any aberration of the cover, in rising or sinking. From the great pressure necessary, when the cover is screwed down, great care ought to be taken that the whole of the supporters of the press be exactly perpendicular; and that the press, when properly placed, should be strongly secured.

"The apparatus being well made, and properly secured, the process of manufacture is remarkably simple. The cloth is woven of the natural colour of the cotton wool; and in this particular, the manufacture, besides the beauty of its appearance, possesses a decided preference, in point of economy, over the Pullicate handkerchiefs, and other imitations of the Indian manufacture, where the pattern is produced in the loom, and the stuff previously dyed in the state of yarn. Whatever care has been taken to prevent the tedious and repeated processes, which are used in the dyeing of Turkey-red, from injuring the yarn, every per-

son, at all conversant with the manufacture of coloured yarn, will be sensible that all the subsequent stages of the operation of forming it into cloth are much impeded by the preparatory change which it has undergone in the dyer's hands; and, from the nature of the process, this, perhaps, applies to no colour in so great a degree as to Turkey-red. It follows, that the wages given to winders, warpers, and weavers, must be raised, in proportion to the impediments which they have to encounter; and to the smaller quantity of cloth, which their exertions can, of consequence, produce. Besides this, all handkerchiefs ornamented in the loom are confined to what is called *checking*; and all the various colours must be interwoven, either parallel, or at right angles to each other, unless very complicated and, consequently, expensive mounting be used. The time consumed in changing the colours of the woof also impedes, in no small degree, the speed of the operation; and thus both the state and nature of his materials, and the mechanical operations necessary to accomplish his purpose, tend, at the same time, to enhance the wages of the weaver, in proportion to the quantity of cloth which is the product of his labour.

"But, as the imitation Bandanas are woven perfectly plain, the same as calicoes, cambrics, and other stout fabrics, no impediment of this kind occurs; and the whole labour and expense are in the subsequent process, and the sum sunk in procuring the press.

"After the cloth is woven, it is cleared from impurities, and dyed Turkey-red, exactly in the same way as yarn is dyed. When the colour is to be discharged, the cloth is neatly folded in squares of about 10 or 12 folds, and laid upon the sole or under plate of the press; the cover being previously elevated, by means of the screw and wheel: the upper and under plates are then firmly screwed together, the cloth being between them. The under part of each of the perforated tubes now presses hard upon the upper surface of the cloth; and being, as aforesaid, per-

pendicularly over the holes in the under plate, no part of the discharging liquor can escape, excepting through the apertures which form the patterns. The press being screwed down, the discharging liquor is poured upon the cover, and, being confined by the rim, passes through the apertures, and discharges the colour from those parts of the cloth which it passes through; being prevented from spreading upon any other part, by the power of the screw. The discharging liquor is received into a trough, placed under the lower plate of the press. From this trough it is conveyed, by a spout, into vessels placed to receive it, and preserved; for, although it loses much of its chemical quality in passing through the cloth and discharging the colour, it retains so much, as still to be of service in many of the inferior operations of clearing and whitening of cloth. The discharge of the colour is effected, by the action of the liquor, in about eight or ten minutes. When the liquor has passed through, the cover of the press is raised, the cloth is taken out; and another piece being substituted, the operation goes on as before.

"When two industrious persons are employed for the purposes of folding the cloth, working the press, and applying the liquor, it is calculated that the operation, for one piece of 12 handkerchiefs, occupies about 15 minutes; consequently, two persons can discharge 48 or 50 dozens of handkerchiefs in one day of 12 working hours.

"The operation requires only care and attention; for if the press be properly constructed, nothing more is required than to fold the handkerchiefs neatly, to lay them square upon the under plate of the press, and to be careful that the cover is tightly screwed down before the liquor is applied. When the handkerchiefs are taken from the press, the discharged spots do not appear white, but of a dull straw colour. The common operation of clearing, however, very soon gives a pure white to the spots, and adds brilliancy to the Turkey-red ground. Those who have been longest in the habit of working these presses, consider a most im-

portant point to be, attention to the cement which is put where the perforated tubes are connected with the cover of the press. This certainly requires frequent and careful examination; for if any of the liquor is allowed to escape here, the ground of the handkerchiefs will be materially injured by its operation upon the colour. As the invention is recent, and the study of practical chemistry rapidly advancing, it is not improbable that some composition, of superior efficacy for this purpose, may soon be discovered. The cement used, answers the purpose tolerably well, but requires great attention on the part of the person to whom the charge of the press is entrusted.

"It has been already observed, that the chemical liquor generally employed is a solution of the oxymuriate of lime.

"The method of preparing this liquor, was discovered, and first introduced into practice, by Charles Tennant, Esq. St. Rollocks, near Glasgow; and is at present universally used, by those engaged in the manufactory. The following remarks upon its practical application have been obligingly communicated to the writer of this article, by that gentleman; which he will copy in his own words:—

"'Agreeable to my experiments, a solution of the oxymuriate of lime, of 1,010 specific gravity, decomposed by $\frac{1}{100}$th part of its weight of sulphuric acid, of 1,846 specific gravity (the usual quality of marketable acid), is the most advantageous preparation for discharging Turkey-red; and what, I believe, is in pretty general use with the trade in this quarter.

"'As the oxymuriate acid is but little soluble in water, when disengaged from its combination with the lime, the sooner it is used, after its separation by the sulphuric acid, the better; and this is done, by simply filling the types with the solution, and allowing it to remain in them for so many minutes as proper, until the discharge is effected.

"'When the discharge is completed, the acid liquor must be carefully washed out of the types, previous to their being removed from their hold of the cloth.'

"It is hardly necessary to observe, that the word *types*, used by Mr. Tennant, refers to the perforated tubes fixed in the cover of the press, and previously described in the mechanical part of this article.

"Some alterations in the construction of the presses has been, very lately, introduced into some of the manufactories. The chief difference from the press described, consists in pressing down the cover by a great weight, instead of the action of the screw. Water has been used to give this weight; and is raised into a trough upon the cover, by means of a forcing-pump, when the pressure is to take place. This may certainly press more equally over the whole surface of the cover, than a screw, which acts only upon one point; and, in this particular, may be an improvement. Few of these presses have as yet been used; but those which have, are said to answer very well."

XVI.—*On the Injuries sustained by Patentees, from the Misrepresentations of a late* Anonymous Journalist. *By Mr.* JOHN BARTON, *Engineer.*

SIR, *No. 44, Seward Street, Goswell Street, July* 17, 1823.

I CANNOT but compliment you on the very proper reply you have made in your last Number, to the *gross attack* of an *Anonymous Journalist;* in which you have not only completely exposed *his ignorance* of the process he saw performed, when he was deluded into the belief that *sheet-iron* was *welded* at a *red-heat;* but you have also managed to extract information for your readers, from his illiberal comments upon your Article "*On Soldering Sheet-Iron with Cast-Iron.*"

I have however, in common with other Patentees, much more serious causes of complaint against him, for the very imperfect manner in which he has published, in a Journal in which he is concerned, extracts from the Specifications of our Patents; and, more especially, for the *malevolent* observations he has chosen to make upon them; by

which, as far as lies in his power, he endeavours to deprive us of that remuneration which we are fairly entitled to from the public, for affording that accurate information, on the nature of our improvements, which we are bound to do, by the conditions of our Patents: and we think that he is certainly liable to damages, in any actions which might be brought against him for such injuries.

In my own case, I have to complain, that, in the publication of my Patent for "*Improvements in Propelling, and in the Construction of Engines and Boilers applicable to Propelling, and other purposes,*" he has only published *three* of the *ten* drawings in the Specification; and those in such an imperfect manner, that they by no means convey an idea of the nature of the improvements. Nor is this all; for, in addition to these misrepresentations, he has given his own opinion respecting them; his qualifications for which you will be better able to judge of, when I have stated the nature of my complaints.

In order that you may form an idea of his misrepresentations, I send you my Specification; from which you will see that he has merely given the cross-section of my steam-engine boiler, and that in so imperfect a way, that it is quite impossible to construct it according to his shewing; and for want of the side-section, it cannot be understood. He also gives a very bad figure of my lift-pump with a hollow bucket-rod; which I should have been ashamed to bring before the public in such a shape. He has also shewn a section of what he calls "the chamber of a forcing-pump," but which I term an "engine for raising water, or other purposes, and well adapted for a fire or blowing-engine:" and here he has entirely mistaken the nature of its construction, *by making the fixed parts moveable, and the moveable part fast!* I cannot, however, make myself well understood, unless by references to Figures.*

* In order that our Readers may fully understand these variations, we shall copy the Figures of the Specification, and those complained of, in Plate IV; and the Specification itself in the following Article.—EDITOR.

Surely, Sir, these things are not to be committed with impunity! The present Editor of the work in question, and who, I conceive, was the *late Anonymous Editor*, I saw yesterday: he laid the fault upon my not sending my Specification to him, as he required me to do by his Circular Letter. But as I knew not what right *he* had to make such a demand upon me, and as I had (as indeed I always do, and advise other Patentees to do likewise,) made my own vellum drawing to be affixed to the Patent Roll*, so of course I did not send it to him.

After manifesting such ignorance respecting their construction, it is surely too much to find the following *malevolent* remarks upon the originality of my inventions, at the close of his article.

"The respective advantages of these inventions are not pointed out in the Specification; and we are not sufficiently aware of their superiority to inform our Readers upon that subject. As to the originality of the plans, we cannot but consider them slight—very slight variations from other inventions which have been long before the public."

I believe the fact to be, that the *Journalist* had suffered himself to be made a tool of, by certain interested individuals, who found him an apt subject to be imposed upon; and that they made him utter these opinions:—this, at least, is the most favourable construction which can be put upon such conduct;—for, if not owing to such instigations, it must be attributed to worse motives.

I am, Sir, your most obedient servant,

T. Gill, *Esq.* Jn°. Barton.

* However accurate the *paper drawings* sent in by Patentees may be, yet, as their patents must stand or fall by *the copies on vellum*, so it behoves them *to see that these are correct also*: and, as they are always made at their own expense, *we recommend that they be furnished by themselves, to ensure their accuracy*; as they can have no controul over the artist employed to make them for the Enrolment Office.

XVII.—*Specification of the Patent granted to* JOHN BARTON, *of Falcon Square, in the City of London, Engineer; for certain Improvements in Propelling, and in the Construction of Engines and Boilers applicable to Propelling, and other Purposes.—Dated May* 15, 1820.

WITH A PLATE.

I the said JOHN BARTON, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained in and by the drawings hereunto annexed, and the following description thereof; that is to say; My invention, as it respects boilers, is in their construction of a strong figure; and to make the flue for the fire and smoke, so as to expose a large surface of fire to the fluid, that the heat may have to ascend as much as possible, in every part I can, to act against a part of the boiler where there is water adjoining; and of such a shape, that they may work without any surrounding brick-work, if desired; as shewn in Fig. 1, (Plate IV.) end-view; and Fig. 2, a side-section. *a a*, shews the fire-place; *b b*, shews the form and situation of the flue, which goes from the fire-place *a a*, and then ascends to the cross-flue *b* 1, from which it returns, towards the fire-place, to *b* 2; when it returns round the pipe *c*, which is full of water, and divides the flue; whence it goes towards the chimney or pipe, *b* 3, where the smoke goes away.

Fig. 3 is a side section of part of a pump or engine, with a hollow rod which I claim as my invention: it answers both for the pump-rod and rising-main; for the water ascends in the inside of the rod, connected, at top, by a joint, or any other method, to allow the water to run off.

Fig. 4 shews a section of a cock in the cylinder-cover of the engine, for feeding it with grease, oil, or any other fluid, without admitting air; or, as at Fig. 5, it may be used for feeding an engine with water, as it answers the purpose of a double-cock: these may be made to revolve by machinery, so as to give the exact supply required; or

be made to rise and fall, with a float in the boiler; and may be used for various other purposes. The chamber must be made larger or smaller, according to the use intended, or quantity of fluid required.

Fig. 6 shews the cylinder-lid, and top of the cylinder; with the cock Fig. 4, shewn on a smaller scale.

Fig. 7 shews the end-section of my engine, for raising water, or other purposes; and is also well adapted for a fire- or a blowing-engine, *as it works with little friction; and has a tendency to improve by use*:—it is shewn with the fan or piston (which is metallic) going towards the left; on which side it is forcing the water up; and the upper valve is open on that side: and it forms a vacuum on the other side, shuts the top valve, and opens the bottom valve to the suction; so that these valves act alternately, and raise water both at the raising and depressing of the handles.

Fig. 8 is a view of the segments of the metallic piston or fan, which are pressed against the diameter and ends of the cylinder, or working-piece of the engine, by the springs.

Fig. 9 is an end view of my wheel or drum, made hollow as far as the dotted lines, for propelling or other purposes: it must be air-tight, and buoyant; and its advantage is, that it has the tendency of keeping at the proper depth in the water, so that the paddles act with the greatest effect.

Fig. 10, an end view of ditto.

References to, and Remarks upon, the Additional Figures 11, 12, *and* 13, *of Plate* IV. *By the* EDITOR.

Fig. 11 is the defective representation of Fig. 1, complained of by Mr. Barton; in which our Readers will see most material deviations from that figure: for instance, in the original figure, the curved representations of the flue terminate on each side in descending parts, which are firmly secured, by rivets, to the cylindrical body of the boiler; whereas, in Fig. 11, they are shewn as mere arcs of circles; and in what manner they could be firmly united with the

cylindrical part of the boiler is left for conjecture. Fig. 12 is intended to represent Fig. 3 of the specification; but differs most essentially from it, in the form of the hollow pump-rod. In Fig. 13, however, the greatest deviations from the specification will be found: this is pretended to represent Fig. 7 of the specification:—and we shall further shew the *misrepresentations* he has made of this part of the specification, by quoting his own words; as follow:

"Fig. 7 (in our Plate it is Fig. 13) shews a section of the chamber of a forcing-pump, in which *a* is what is commonly called the suction-pipe; *b*, *b* 1, *b* 2, is the chamber; *c*, and *d*, are *fans* acting as *pistons*; *e*, and *f*, may be supposed to be the levers, or arms, which work the fans. Upon the right-hand lever being depressed, as shewn in the figure, the valve or *clack*, *d*, will open, and the water flow through it into the right-hand space of the chamber, *b* 2. Upon the left lever, *e*, being depressed, the fans will alter their situation, the clack, *d*, will close, and the clack, *c*, open, by which the water will flow through *c*, into the left-hand part of the chamber, *b* 1; at the same time, the water, which occupied the right-hand side of the chamber, *b* 2, will, by the fan, *d*, be forced out through the clack or valve, *h*, then open, and pass into the *breeches-pipe*, *i*, *i*. Another stroke of the pump (that is, by again depressing the lever, *f*,) will bring the fans, *c*, and *d*, as seen in the figure, and force out the water from the chamber, *b* 1, through the clack, *g*, into the breeches-pipe, *i*, *i*. Thus the water accumulating in the breeches-pipe, becomes forced up into the air-vessel, *j*, in which the elasticity of the air, acting upon the water, ejects it with considerable force through the exit-pipe, *k*, and thus the apparatus may be used as an engine for extinguishing fire, &c."

The Reader will observe, on referring to the specification, that the division of the chamber into the chambers *b* 1, and *b* 2, is the invention of the *Anonymous Journalist:* so also are the *fans*, there being only one in the specification, and that working above; whereas he has shewn two work-

ing below. He has also converted the working-fan or piston above, into a fixed division-plate; and changed the two plates below, which separate the suction-pipe from the chamber, *into two working-fans or pistons, acting in the midst of the sand, gravel, &c. brought up with the water; instead of one only, working above, and out of the reach of those abrading substances,* as shewn in the specification. As for *the segments of the metallic piston or fan,* described in the specification, as being pressed against the inside of the cylinder by the springs, *he has entirely omitted to mention them.*

We really are surprised at *the alterations for the worse* which the Anonymous Editor in question has dared to make in the figures and descriptions of the inventions; and still more so at the *arrogant manner* in which, *after thus exposing his ignorance respecting their construction,* he has presumed to pass judgment upon their advantages and originality.

XVIII.—*On the Culture of the Beet, in France, for the Extraction of Sugar and the Nourishment of Cattle.*

[Continued from p. 65.]

OF the seed of beets in general, (the yellow and red, 4th and 5th varieties,) that which comes from Castelmandary is the most esteemed. There is really a remarkable difference the first year that it is sown; but this difference diminishes year after year, till at length it is lost entirely.*

3d Sub-variety—Is small, yellow, shaped like a carrot, has yellow petioles, but is never cultivated.

4th Sub-variety—Is yellow exteriorly, and white internally; tapering, rounded, has white petioles, and a rather saccharine juice, but its culture is not very profitable.

It results from this enumeration, that, amongst all these *varieties* and *sub-varieties* (of which many more might have

* It appears that seeds collected from a warmer climate arrive at more complete maturity, and acquire a greater vital strength. M. Vilmorin Andrieux, a very respectable seedsman of Paris, receives seed from Castelmandary every year. From him, all the varieties, and the greater part of the sub-varieties above mentioned, may be obtained.

been given), two only can be cultivated for the purpose of extracting their juice; which are those comprised under the Numbers 2 & 5; and of these, Number 2 is generally preferred. The finest *seed-bearers** must be carefully preserved. It is necessary to examine attentively, if there are any red or pink veins visible in the petioles of the leaves or their necks, and that they do not indicate any tendency to change the variety; but, with all possible care, some of the sub-varieties which we have described, or some others, will occasionally appear.

The beets are dug up as soon as they have attained their full size; and even a fortnight before, they begin to take them up, as wanted. The second variety (the *beta alba*) may be treated in this manner for three months; and they yield much more sugar than when they are dug up a long time after they have attained perfection, and still more if they have been housed.

Soil.—If it is of importance to choose the seed of those beets which are most proper for the manufacture of sugar, it is still more important that they should be sown in a suitable soil. In fact, whatever may have been the variety sown in a soil which is too dry, the beets will be small and hard, contain but little juice, and be difficult to rasp: if the soil contains a great quantity of flint, chalk, or gravel, the beets will be ill-shaped, and composed of a great number of small radicles; which are all loss, as they must be picked off; and we consequently obtain but little juice from the beets: if the soil be too moist, it may happen that the seed perishes, and never shoots at all†; and if the beets do appear, they grow too fast, are extremely aqueous, and but little saccharine. It has been imagined, that,

* The cultivators call those *seed-bearers*, which are replanted, to be left to *run to seed* the second year.

† It is very requisite to seize the most favourable time: after a little rain, which has slightly moistened the earth, we are certain that the sowing will be successful. Sometimes endeavours are used to remedy this deficiency, by steeping the seed; but this practice is prejudicial; many inconveniences result from it, and, among others, it renders the seed more liable to be attacked by insects, which destroy it.

in this case, the same quantity of sugar might be found, though diluted with a greater quantity of water; but even granting this supposition, the extracting of it would be much more difficult. In fact, I have always remarked, that in the degree that the juice was weak, it produced a greater proportion of *extractive matters*, instead of sugar. The strong clayey soils produce another inconvenience; for even supposing that the beets have come up well, and not suffered until they had attained a certain size, either from humidity or dryness, even then a few hot days are sufficient to harden the surface of the soil so as not to allow of any more growth in the tops of the plants; the plants will be in a manner *strangled*; and whatever favourable circumstances may occur afterwards, they will never regain their vegetative powers.

In a soil where the vegetable earth is not sufficiently deep, or where the digging or ploughing has been shallow, the lower extremity of the root, meeting a hard bottom, will be arrested in its progress, and will shoot upwards; the root becoming ligneous, and green in that part which is exposed to the air*.

A proper soil for the *useful* cultivation of the beet, in regard to the extraction of its juice, must be sufficiently *light* to promote the growth of the plant; it must also be *deep*, and not stony, so that the principal root may shoot perpendicularly downwards, without meeting with any obstacle: it must not be susceptible of being converted into mud with the least rain, nor liable to crack in dry weather. The manure best suited for it, is dung, that has been reduced to the state of earth (*humus*), whether it be produced from animal or vegetable matters: it must not produce any *active fumes*, nor contain any *saline matters*. †

* All the roots are sensibly more saccharine in those parts which are farthest from their tops; and this effect is much more distinguishable when the land producing them is light.

† I have obtained, as well as many other manufacturers, who have operated upon the beet in the vicinity of Paris, a crystallization, which contained as much salt-petre as sugar; and as these two substances are very difficult to separate in the large way, on account of their solubility in water being nearly equal, a double loss results from this circumstance.

The *maximum** of useful produce from beets has been obtained from old meadows newly broken up, and in the two or three first years which have succeeded the taking up of trees, and when leaves and chips of wood only have manured the soil. Thus we see that the *physical* qualities of the soil concur much more than its *chemical* properties to produce good beets. In fact, *pure sand* placed under those circumstances, in regard to heat and moisture, which are the most favourable to the growth of beets—will produce a more excellent and saccharine juice than, probably, the greater part of those grown in mixtures, either of lime, clay, or flint, and in which the various manures known should have been purposely combined.

Mode of culture.—It has been long thought, that, in order to obtain the best beets, and in large quantities, the soil should be changed every three years: but it has been lately proved, that, in a good soil, the beets will yield an excellent product, for many years together, and without any other *manure* then their own leaves, left upon the land after taking up the roots: nevertheless, if we would derive the greatest possible advantage from the land,—and profit by the cleansing it receives from the second turning up of the ground, which beets require, for their culture to be profitable,—a rotation of four years produces the best results. The farmers might let this fourth year to the manufacturers of sugar: and the former would have the advantage of their land being enriched, without expense of dung, or the loss arising from being left fallow; and the latter would be, by this means, also freed from a considerable expense in the purchasing of land and cattle†. The rotation may also be effected, with advantage, in the following order; viz. barley, clover, wheat, beet, &c. We obtain still greater advantages from cultivating, in succes-

* Fifty thousand kilogrammes per hectare. (The mean product is from 20 to 25,000 kilogrammes.)

† M. Matthew de Dombasle has particularly insisted upon this point. See "*Faits et observations sur la culture et la fabrication du sucre des betteraves,*"—*Annales d'Agriculture.*

sion, wheat, beet; wheat, barley, clover. It has been completely proved, that land cultivated by introducing crops of beet alternately has been the most productive in corn, other circumstances being equal. M. Chaptal says, in a very interesting Memoir on the beet*: "I allow the leaves to remain on the land, sow corn upon it, and harrow them in the usual manner; thus, my harvest of beets is an intermediate one, which does not deprive the estate of one single grain of corn."

In very light soil, one ploughing is sufficient; but, in general, it is necessary to loosen it twice, and to give it such dressing as may be required to fulfil the conditions indicated: it is indeed requisite, in certain compact soil, to plow it three times.

Sowing the seed for beet.—It is sown in the latter end of March, choosing as favourable a time as possible (see above). The most simple method of sowing the seed of the beet, or indeed any other seed, is what is called the *broad-cast*. This is also the preferable mode when we cannot procure good sowing-machines, or when the price of hand-labour is not very considerable. This mode of sowing presents the following advantages: The beets produced from the best seed, are, as it were, placed by chance in the most favourable circumstances, that is to say, in a proper depth of soil, and of the requisite humidity, to produce the most vigorous plants; and they will be easily preserved, when, at the first *thinning* we must *clear away* or draw out the excess of the roots, according to the quality of the soil. We are certain, that the roots which appear the best in their first stage, will also be those which will produce the most sugar, and that in a very considerable degree.

In large establishments, it is much better to employ a sowing-machine, drawn by a horse†. The advantages of

* Read at the sitting of the *Institute*, the 23d of October, 1815.

† The great cultivators of the beet have generally adopted this method, with some few modifications: it is used in the environs of Paris, particularly

suffered in any way. It is now well known, that we must not, in any case, strip the beets of their leaves, during the course of their vegetation. The profit obtained by making use of the leaves is more than counterbalanced by the injury which the beets sustain from the least wound.

Taking up and preserving the Beets.—Beets have generally acquired their perfection, and are completely mature, towards the end of September, or in the first days of October: this is, however, rather too soon for the southern parts of France; and too late for the more northerly parts. From the moment that the beets cease to increase by remaining in the earth, they must suffer, by an alteration in the sugar formed; as may be remarked in all annual vegetables of a saccharine nature*: they must then be taken up; and there is no better time, if they are intended exclusively for the feeding of cattle. It is not exactly the same, if they are intended for the extraction of sugar: in the latter case, if the labours of the field can be rendered independent of the manufactory, which depends entirely on locality, (such as, the mode of culture in that part of the country, the expense of labour, &c. &c.) it would be highly desirable to commence the manufacture a fortnight before the entire maturity of the beets, and to continue it during the taking them up. By this practice a great advantage would be obtained; for, if we could work in this manner for three months, whilst the whole of the raw sugar was made, we might be sure of obtaining a much greater quantity than could be had by using the best methods of preserving the beets for five or six months. But, as this is not possible, and they have not the means everywhere of manufacturing the sugar at the moment of taking up the beets, as that would increase the expense too much; so a part of them,

* I have, nevertheless, preserved beets from one year to another, and they even contained more sugar in the month of February following than at first: but then I covered them with a large quantity of earth (about 33 centimetres), so that they might not vegetate. In fact, if, after they are uncovered, they begin to grow, their saccharine quality is totally exhausted.

at least, must generally be kept in store†. It is therefore very desirable to find the means of preserving them perfect; but it has been proved, that, among the numerous methods which have been resorted to, no one has attained this end. We will next point out the principles on which we must act, to retard as much as possible the alteration of the juice contained in the beet-roots; we will then say a word or two on the means employed; and finish, by pointing out what experience has demonstrated to be the best.

Vegetation must on no account continue after taking up the beets, because that always proceeds at the expense of the sugar: the beets, likewise, must be wounded as little as possible, or their skin cut; for in every part where organization is destroyed, the vital energy ceases, and fermentation commences: these changes follow each other in rapid succession, and the alteration is quickly communicated to the surrounding parts. As it is impossible, however, to avoid all fermentation, the heat produced must, at any rate, find a free vent: for if it should accumulate, the effects of these partial fermentations, augmenting by degrees, would soon be communicated to the whole mass; and even in the first stage, when they are not visible in the outward appearance of the beets, there remains no longer any crystallizable sugar in them, and in a very short time they entirely perish. We must also carefully prevent their being attacked, in the slightest degree, by frost. In such case, the water which they contain increases its volume by becoming solid, bursts all the vesicles which contain their juices, and their organization is completely destroyed. The ice formed, it is true, opposes all tendency towards fermentation; but when, afterwards, the temperature begins to rise, the juice issues from the torn fibres, and thus, left to itself, ferments in a few minutes, and all

† We should always endeavour to make use of the beets as quickly as possible, and store as few as we can. Four months appears to be the longest time this treatment can be continued, without hazarding the chance of a very considerable loss in sugar.

the sugar is then decomposed. Finally, we must prevent any damp beet-roots from being placed amongst them; because the water, being charged with soluble vegetable matter, puts the whole mass into fermentation*.

The experiments on preserving beet-roots, as well as seed, have been too numerous for us to mention; but the principles which we have explained are, we think, sufficient to prevent any very considerable losses being caused by uncertain experiments.

In sandy soils, or high ground, we have succeeded in preserving beet-roots for three or four months, by the following method: Rub them first with the hand, to clean them from the earth, but carefully avoid cutting or bruising them; then twist off the leaves, to free the roots as much as possible from their heads, but without wounding the roots: range them, thus prepared, in furrows of two metres wide, and of a moderate length; but separated, every two and two metres, by a space of twenty centimetres, which must be afterwards filled up with the sandy earth. In the middle of each heap, a hole must be left, of about fifteen centimetres wide, for the issue of the vapours: this hole is formed by placing a piece of wood in the heap, whilst it is forming, and withdrawing it after the beet-roots are arranged. Neither leaves, boughs, nor straw, must be placed round the beets (as has been repeatedly done): all these substances very soon change, and concur to spoil the beet-roots. It is sufficient to cover them with earth, which is raised into a mound, and beaten into such a shape, that the rain may easily run off.

One of the methods most in use, and which, with the precautions above indicated, generally succeeds, consists in arranging the beet-roots in large caves or pits, in which

* If, during the taking up of the roots, rain should come on, it will be better to wait till the weather changes, before we continue the operation: and, in every case, it is better to spread the damp beets under cover, in order that they may be as dry a possible when they are housed.

the temperature cannot be elevated above twelve degrees, and never be so low as the freezing point †.

It may, probably, be interesting to some, to see the expense of the cultivation of the beets, by different manufacturers of sugar in France, in different situations.

Some of my correspondents, from whom I have collected these observations, and who are very willing that their names should appear, are too enlightened, have acquired too much experience in this kind of culture, and are besides too honourable, to have their results suspected: but slight inaccuracies are inevitable in such appreciations.

Table of Comparative Expenses in Cultivating the different kinds of Beet, in the various Departments of France.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Rent and taxes . . .	25	35	24	40	40	20	40
Ploughing & harrowing	24	18	48	6	. .	15	30
Manure	50	12	18	. .	10.70	. .	60
Sowing	25	3		4.80	. .	15	19
Weeding and hoeing.	20	15	30	13	16.60	22	25
Taking up	40	10	20	20	18	12	22
Cartage		10	20	11	10	12	20
Preservation	. .	6					10
Interest of money, and profit	. .	25	20	. .	. .	15	25
Total expenses . .	184	134	180	94.80	95.30	111	251
Beet-roots produced, kil	10,000	12,500	10,000	5,500	6,000	7,750 to 10,000	10,000 to 15,000
	f. *c.*	*f.* *c.*	*f.* *c.*	*f.* *c.*	*f.* *c.*	*f.*	*f.*
Cost of manufacturing 1000 kil.	18 40	16 75	18 00	17 05	15 85	15 to 12	25 to 17

† I have preserved beet-roots by arranging them in very large caves on a thick bed of coarse animal charcoal, adding, successively, a layer of beets, and one of charcoal; then another layer of beets, &c. to the height of two metres. When I withdrew them for use, although they were somewhat moist, yet they had diminished both in volume and weight, being dried by the hygrometric power of the charcoal: they were, however, very saccharine; but, by losing their water, the outside skins adhered very closely, and they were very difficult to rasp. The juice which I obtained from

No. 1.—M. le Compte Chaptal, one of the manufacturers of sugar from beet, who has most contributed to encourage this manufactory in France, both by precept and example. His manufactory is situated at the castle of Chanteloup, in the Department of the Indre and Loire, near Tours. The extent of his land, as shewn in the above table, is equal to an arpent, or $\frac{1}{2}$ an hectare.

No. 2.—M. Crespel Delisse, manufacturer at Arras, in the Department of the Pas-de-Calais, and at Channy in the Department of the Aisne. He has employed himself for twelve years in this species of manufacture, and still finds considerable profit to result from his two manufactories, which he conducts with great ability: he exclusively cultivates the white beet, the variety above described as No. 2. He employs a sowing-machine, and hoes drawn by horses. His calculations apply to a quantity of land containing 100 rods, of 22 feet.

No. 3.—M. Lestelle, director of General Preval's manufactory near Blois: he established, and has conducted this manufactory for three years, with great zeal. He employs machines for sowing and weeding. The variety which he cultivates is the white beet, No. 2. His calculations apply to a quantity of land amounting to 1,600 square toises, or 60 ares, or 78 centiares.

No. 4.—M. Masson: his manufactory has been established for eight years, at Pont-à Mousson, near Nancy, a Department of la Meurthe: he cultivates the white variety, No. 2. The day's work of land, indicated in the table, comprises 300 rods, of ten feet in length: he has made some very ingenious observations on the culture and treatment of beets.

No. 5.—M. Andrè. His establishment is not very dis-

from them, with much trouble, and by the addition of water during the pressing, afforded nearly as much sugar as I should have drawn from them in treating them when freshly taken up. This process, which it would be impossible to apply generally, may, nevertheless, contribute to clear up the theory of the alteration in the beets; and may, perhaps, be applied to the preservation of other vegetables of more value.

tant from the last mentioned: he cultivates the same variety of beet; and the surface of land pointed out in the table is the same.

No. 6.—M. Grenet Pélé, at Toury, a Department of the Eure and Loire: he cultivates his land entirely by hand-labour; and now employs himself in improving his culture and manufacture.

No. 7.—M. Demare, Ex-Mayor of Aubervilliers, called *Les Vertus*, near Paris. The beets on this plain are now only cultivated, as we have before stated, to be sold at the Hall, and to cattle-feeders in Paris and its environs, who find it very advantageous to make use of this food for their cows. The beet-roots sell at 24 to 30 francs the kilogram; and they cost the cultivator, as we see, from 17 to 25 francs: but this sort, as before observed, is not proper for the manufacture of sugar.

We might give the average expense of beets in many other establishments, where the cultivation is exclusively intended for sugar; such as that of the Duke of Ragusa, at Chatillon, on the Seine; of M. Bernard, at Sucy; of M. Michel, at Villiars's Refining establishment, near Magny (Seine et Oise), &c.; but this would occupy too much time, and the expense of their culture will be comprised amongst those already cited. P.

XIX.—*On Bronze Statues, and Medals; and on Cannon, Bells, &c.*

[Continued from p. 57.]

Coining of Medals in Bronze.—In order to prepare the cast medal for the first stroke of the press, the coiner should place it in the dies with very great care. In fact, the outline being then but just marked by the moulding and casting, as we have before stated, the striking is not very easy; but after the first blow, the impression of the dies having been received in many parts, the striking no longer presents any difficulties. In three or four impressions, according to the model, a medal may be finished*. Between every

* One impression is generally effected by three successive strokes of the press, as in ordinary coining.

impression, the medal should be *annealed* and quenched, in order to render the bronze sufficiently malleable to rise by the percussion of the press *.

We conceive, that, with those metals which are very malleable, such as gold, silver, copper, &c.† medals may be manufactured without any preparatory moulding and casting: when they place the *blank-pieces* under the press, (that is to say, equal-sized circular discs, cut out of laminated sheets of either of these metals,) the molecules being strongly compressed and retained from spreading horizontally by the ring or ferule, yield to the percussion and slide by each other vertically, and thus fill up the hollows in the dies. Nevertheless, although tempered steel is much harder than these *pieces*, it often happens that the dies, whether more or less tempered, will not resist a great number of impressions, and particularly when the reliefs are considerable, and opposite to each other; which renders the manufacture of such medals long and tedious ‡. In this case, the dies strike for a long time very imperfectly, because their hollows only fill by degrees; and, after a certain number of blows, the metal can no longer sustain them without becoming hard, and cracking. The hardness of the metal being thus opposed to the action of the dies,

* It appears that, in the *annealing*, the molecules of the bronze, which had approached each other under the action of the press, are hereby expanded again; and hence results a difference in the density of the medals. According to the observations of M. de Puymaurin, the density of the alloy, struck and annealed, is greater than at its first coming from the mould; and this density augments to a certain degree; after which, (as after three or four blows of the press for instance,) the alteration being much less, the density remains nearly the same.

† Medals are manufactured of these metals, at the following standards:
Gold medals are an alloy, of 85 parts of copper, and 915 of gold.
Silver medals ditto 50 . . . copper, and 950 of silver.
Copper medals are without alloy; as are also those of platina.

‡ The number of blows which medals will bear, depends on their relief, which is generally proportioned to their size. We may estimate them as follows:

	Impressions and Annealings.	Blows of the Press.
Medals of 18 lines in diameter,	from 5 to 6	from 10 to 12
Medals of 22 ditto	7 to 8	14 to 16
Medals of 25 ditto	12 to 16	24 to 32
Medals of 32 ditto and upwards	30 to 40	90 to 120

it is absolutely necessary that all the *pieces* should be prepared by casting, as we have above mentioned; so that as little as possible may remain to be effected by the dies*.

(*To be continued.*)

XX.—*Queries, on Artificial Fountains, &c. By a* CORRESPONDENT.

Antingham, near North Walsham, Norfolk, July 21, 1823.

SIR,

PASSING, a few days ago, through the Village of Tooting, in Surry, I was much gratified by seeing a *Fountain*, which I was informed is perennial, produced by the newly-devised mode of boring into the earth. The beauty, as well as the manifest utility of such an ornament, and which, if I am rightly informed, is not so expensive as the common process of sinking a well and putting down a pump, makes me wonder that you have not noticed it in your valuable Repository.

You give us, it is true, a great deal of information, highly excellent indeed, but omit to notice the more humble, because less pretending and less scientific matters; which, however, come more immediately home "to men's business and bosoms," and tend *more directly* to the benefit of all mankind. How many millions, for instance, would be benefited, by imparting to them an easy and economical method of raising water, or, rather, of *enabling water to rise of its own accord!*

These, and such as these, are arts of universal utility:

* We see that, in medals of bronze, the action of the press is employed to finish their contours, as well as the minuter details of the impressions, whatever may be their relief; and the efforts it makes are confined entirely to their surfaces: whilst in the ordinary coining of pieces of pure copper, the number of impressions and annealings necessary, depends both upon the extent of surface of the model, and the height of its reliefs; as the effect must always be greater, in proportion to the molecules it has to displace. We may also observe, (see above) that four impressions are sufficient to finish a bronze medal of considerable relief; whilst forty are sometimes requisite for those in copper.

and without at all detracting from the real merit of your work, I must once more *press upon you* the propriety, nay, the necessity, of devoting some of your pages, at least, to articles of this description. We care not whether such matters are new or old: all we want is, that they shall be *practicable* and *useful*.

I took the liberty, once before, of suggesting thus much to you; and I now venture to urge the same subject again. I am very sure, that, by attending to my suggestion, you will increase the utility as well as the circulation of your work; and, at the same time, fill up a chasm in our Periodical and Scientific Literature, which thousands have long deplored. I am, Sir, your very obedient Servant,

THOMAS GOOSE.*

Queries.

The expense of boring, per foot;
The implements, and their cost;
The cost of the pipe;
The cost of the external part of the Fountain;
The best mode of judging of the depth to which the bore must probably extend:
And any other matters connected with the process.

P. S. No satisfactory answer has yet been given to my Queries, concerning the Book-worm.

EDITOR'S REMARKS.

We have long had our attention directed to the important benefits resulting from this novel mode of creating artificial fountains; and purpose to lay before our Readers what information we have been enabled to acquire respecting the method of boring for them, &c. As, however, we are still deficient in many particulars, for want of having had an opportunity of witnessing the process, we shall feel obliged to any of our Readers who may be enabled to afford us *accurate information* thereon.

* For the former communications of our esteemed Correspondent, see Vol. I. p. 183; and Vol. III. p. 212.—EDITOR.

XXI.—MISCELLANEOUS.

On Prison Labour.

We have just been favoured by Sir John Cox Hippisley, Bart. with a copy of his treatise on the above important subject, just published.

We entirely agree with him in opinion, that it would be highly desirable to employ the prisoners in handicraft pursuits, whereby they might gain an honest livelihood on their discharge from prison; such, for instance, as those did who had been employed as stone-masons, and by which they became capable of earning eighteen shillings a-week.

We sincerely hope that his fears, and those of Dr. Good, as to the *possible* ill-effects of the tread-mills upon the prisoners, may be unfounded; as, indeed, the great mass of information hitherto obtained seems to prove: and we trust that nothing will happen to cause their removal; as it is utterly impossible to employ the human power, as a mechanical agent, to such great advantage in any other way; *for even the lazy are made to contribute, by their weight, their due share of acting power; instead of burthening the more industrious with the greater part of the labour, as usual.*

As to the proposition of substituting the *hand-crank mills* in their stead, we can only say, that *there is scarcely a worse mode of bringing the strength of men into action;* nor any, in which so little good is obtained from their exertions; and, more especially, when they are employed, as shewn in the plate accompanying the treatise, *in turning single cranks of great length:* it would be much better to divide the crank in the middle, and to afford it a proper support to turn in; *but still more advantageous, to bend the two parts of the crank at right-angles to each other,* as the men would then be able to help themselves in those parts of the movement where they have scarcely any power.

The *rowing posture* well deserves to be brought more into use than has hitherto been done; and, next to the tread-mill, is the best mode of bringing the human force into action. We sincerely wish that our mechanists would turn their thoughts to an effectual and convenient method of applying it to practice: it is certainly highly deserving of a trial. At present, we believe, it is chiefly confined to the diamond-cutters, who actuate their cast-iron mills, by means of a horizontal lever turning on a fulcrum at one end of it, the power being applied to the other: a connecting-rod, near the fulcrum, communicates motion to a crank upon the upright axis of the band-wheel which drives the mills.

This movement is evidently applicable to corn-mills, and with great advantages over the usual methods of driving the stones; as there would be no occasion for *bevel-wheels*, which are so expensive and difficult to construct, and, *at best, are attended with a great loss of power from friction:* neither would any other *toothed-wheels* be required; as we believe it is possible, in this way, to drive the stones merely *by band-wheels and bands of a sufficient breadth.*

Should, however, the *rowing-posture* be objected to, it is evident that the *capstan* may be employed to actuate them with advantage, though not with so little expenditure of human labour as in the former case.

We are sorry to learn, from the treatise, that the old *Walking-wheel* is likely to be introduced into some of our Northern prisons; as we entirely agree with Dr. Gregory*, in his humane observations, that "although nothing but *necessity* can justify the hazarding the lives of men, yet the *Walking-wheel* is attended with *imminent danger; and being a very defective engine, either without necessity or expediency, those persons who use them are responsible to humanity for the shocking disasters they frequently occasion.*"

* See his *Mechanics*, Vol. II. p. 167.

LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal, since June 26, 1823.

To Moncrieffe Willoughby, of Fair Street, Horsley Down, in the county of Surry, Gent.; for certain improvements in the construction of Vessels, so as to enable them to sail with greater velocity. Dated June 26, 1823.—To be specified in six months.

To John Green, of Mansfield, in the county of Nottingham, Whitesmith; for certain Machines used for Roving, Spinning, and Twisting Cotton, Flax, Silk, Wool, or other Fibrous Substances. Dated June 26, 1823.—In six months.

To William Vere, of Crown Row, Mile-end Old Town, in the parish of Stepney, in the county of Middlesex, Engineer; and Henry Samuel Crane, of Stratford, in the parish of West Ham, in the county of Essex, Manufacturing Chemist; for their improvements in the manufacture of Inflammable Gas. Dated June 30, 1823.—In six months.

To Thomas Woolrich Stansfeld, of Leeds, in the county of York, Worsted Manufacturer; Henry Briggs, of Luddendenfoot, in the parish of Halifax, in the said county, Worsted Manufacturer; William Richard, of Leeds, aforesaid, Engineer; and William Barraclough, of Burley, in the parish of Leeds, aforesaid, Worsted Manufacturer; for improvements in the construction of Looms, for weaving Fabrics composed wholly or in part of Woollen, Worsted, Cotton, Linen, Silk, or other materials; and in the Machinery and Implements for, and methods of, working the same. Dated July 5, 1823.—In six months.

To George Clymer, of Finsbury Street, Finsbury Square, in the county of Middlesex, Mechanic; for certain improvements on Agricultural Ploughs. Dated July 5, 1823. —In six months.

To John Fisher, of Great Bridge, in the parish of Westbromwich, in the county of Stafford, Ironfounder; and

John Horton the Younger, of the same place, Manufacturer of Steam-Boilers; for improvement in the construction of Boilers for Steam-Engines, and other purposes where steam is required. Dated July 8, 1823.—In two months.

To Stephen Fairbanks, of the United States of America, but now residing in Norfolk Street, Strand, in the county of Middlesex, Merchant; in consequence of a communication made to him by a certain Foreigner residing abroad, for certain improvements in the construction of Locks and other Fastenings. Dated July 10, 1823.—In six months.

To John Leigh Bradbury, of Manchester, in the county of Lancaster, Calico Printer; for his improvements in the art of printing, painting, or staining silk, cotton, woollen, and other cloths; and paper, parchment, vellum, leather, and other substances; by means of Blocks, or Surface-printing. Dated July 15, 1823.—In six months.

To Bennington Gill, of Birmingham, in the county of Warwick, Merchant; in consequence of a communication made to him by a certain Foreigner residing abroad; for certain improvements in the construction of Saws, Cleavers, Straw-Knives, and all kinds of implements that require or admit of Metallic Backs. Dated July 15, 1823.—In six months.

To Sir Isaac Coffin, of Pall Mall, in the County of Middlesex, Baronet, Admiral of the White Squadron in our Fleet; in consequence of a communication made to him, by a certain Foreigner residing abroad; for a certain method or methods of catching or taking Mackarel and other Fish. Dated July 15, 1823.—In six months.

To William Palmer, of Lothbury, in the city of London, Paper-hanger; for certain improvements in Machinery, applicable to printing on calico, or other woven fabrics composed wholly or in part of cotton, linen, wool, or silk. Dated July 15, 1823.—In six months.

THE

TECHNICAL REPOSITORY.

XXII.—*Explanation of the Measures taken to do away with the Inconvenience arising from Copper Smoke.* By J. H. VIVIAN, *Esq.* F.R.S. *&c.*

[Concluded from p. 90.]

Results of Experiments, made at the Hafod Works, by Messrs. PHILLIPS *and* FARADAY, *in July and August,* 1822.

1. DEPOSIT *from the Calciner Flue, just before the Shower Chamber.*—The flue hot; the deposit dry and dusty; when taken out, had the smell of arsenic; heated with black flux, gave faint indications of arsenic; examined by acid, contained no copper.

2. *Scum from the water at the first Shower Chamber, Ore-Calciner Flue.*—Black and acid; principally metallic arsenic, but with some white arsenic, and a little sulphur; no copper by nitric acid, or in solution.

3. *Scum from the water of the second Shower Chamber, Ore-Calciner Flue.*—A black portion, as above; and a white portion, almost pure white arsenic.

4. *Sediment from the trough of the first Shower Chamber, Ore-Calciner Flue.*—Well washed, and the fine black portion separated from the heavy sand; the black portion gave, with flux, abundance of arsenic; the heavy sand, boiled in water, abundance of arsenious acid, or white arsenic.

5. *Water from the trough of the first Shower Chamber, Ore-Calciner Flue.*—Contained no copper nor iron in solution, but abundance of arsenic.

6. *Water from the trough of the second Shower Chamber,*

Ore-Calciner Flue.—Contained arsenic in solution; no copper nor iron.

7. *Water from the trough of the first Shower Chamber, Metal-Calciner Flue.*—Contained a little iron, no copper, but some arsenic.

8. *Water from the trough of the second Shower Chamber, Metal-Calciner Flue.*—Contained more iron, no copper, but abundance of arsenic, far more than the preceding.

9. *Deposit from the Calciner Flue, after the Shower Chambers.*—Heated with black flux, gave a small trace of arsenic: the flue was very cool, and the deposit wet and muddy: the deposit, examined by nitric acid, contained no copper.

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10. *Water from the first large chamber, Ore-Calciner Flue, taken at the first exit pipe: temperature* 112°.—Estimated both sulphuric and sulphurous acids.

Half a pint gave 17.5 grains of sulphate of barytes.

One gallon contained 37.92 grains of sulphur.

11. *Water from the second large chamber, beyond the junction of the two Flues: temperature* 65°.

Half a pint gave 18.75 grains of sulphate of barytes.

One gallon contained 40.64 grains of sulphur.

12. *Water from the first Shower Chamber, Metal-Calciner Flue: taken at* 5 *a.m.—Bridge-holes* * open; no steam.

Half a pint gave 3.5 grains of sulphate of barytes.

One gallon contained 19 grains of sulphuric acid.

This water, not boiled, but treated for sulphuric and sulphurous acids:—

Half a pint gave 15.75 grains of sulphate of barytes.

One gallon contained 34.24 grains of sulphur.

13. *Water taken at twelve o'clock at night, from the same chamber; from the first exit pipe.*

Half a pint gave 16.5 grains of sulphate of barytes.

One gallon contained 35.8 grains of sulphur.

* Of Sheffield's Patent *Air-Conductors* in the Furnaces.—EDITOR.

FIRST STEAM EXPERIMENT.

14. *Water taken from the general stream of the trough of the first chamber, on the Metal-Calciner Flue.*—The sulphurous acid converted into sulphuric acid, and precipitated.

Bridge-holes open: no steam. Temp. 96° F.
Half a pint gave 13.5 of sulphate of barytes.
One gallon contained 29.28 grains of sulphur.

15. Bridge-holes open: steam on ten minutes. Temp. 107° F.
Half a pint gave 13.5 grains of sulphate of barytes.
One gallon contained 29.28 grains of sulphur.

16. Bridge-holes open: steam on 40 minutes. Temp. 110° F.
Half a pint gave 13.4 grains of sulphate of barytes.
One gallon contained 29 grains of sulphur.

SECOND STEAM EXPERIMENT.

The water taken at the first exit pipe of the first Shower Chamber, Metal-Calciner Flue.—The sulphurous acid gas was driven off, and the sulphuric acid only estimated.

17. Bridge-holes shut: no steam. Temp. 113° F.
Half a pint gave 6.25 grains of sulphate of barytes.
One gallon contained 33.87 grains of sulphuric acid.

18. Bridge-holes shut: steam on. Temp. 128° F.
Half a pint gave 7 grains of sulphate of barytes.
One gallon contained 38 grains of sulphuric acid.

19. Bridge-holes open: no steam. Temp. 109° F.
Half a pint gave 7.5 grains of sulphate of barytes.
One gallon contained 40.8 grains of sulphuric acid.

20. Bridge-holes open: steam on. Temp. 125° F.
Half a pint gave 7.2 grains of sulphate of barytes.
One gallon contained 39 grains of sulphuric acid.

LIME EXPERIMENTS.

21. *Lime-water passed six times through the Shower Chamber; after boiling, to drive off the sulphurous acid.*
Half a pint gave 8 grains of sulphate of barytes.

One gallon contained 43.6 grains of sulphuric acid. Sulphate of lime was also deposited.

22. Lime-water (Cream of Lime) passed once through the Shower Trough, without boiling.

Half a pint gave 10.5 grains of sulphate of barytes.

One gallon contained 22.8 grains of sulphur.

23. Water from the first chamber, Ore-Calciner Flue, boiled and precipitated by acetate of lead.—The precipitate dried, and heated with sulphuric acid, gave fluoric acid in abundance.

SMOKE, &c. &c.

24. Air from the Ore-Calciner Flue, just before it entered the Shower Chamber; taken to windward.

Sulphurous and carbonic acid gases, absorbable by water	Acid gases	10.64
Oxygen		8.94
Nitrogen		80.42
		100.00

25. Air from the Ore-Calciner Flue, just before it entered the Shower Chambers; taken to leeward.

Acid gases	9.28
Oxygen	9.66
Nitrogen	81.06
	100.00

26. Air from the Flue, after all the Shower Chambers.

Sulphurous and carbonic acid gases, absorbable by water	7.22
Oxygen	13.40
Nitrogen	79.38
	100.00

WATERS TAKEN OCT. 1822. EXAMINED BY MR. PHILLIPS.

27. Water from the first Discharging Pipe, in the first Shower Chamber, Metal-Calciner Flue.

18 grains of sulphur, in the state of sulphuric acid.
21 ditto ditto sulphurous acid.
39 total sulphur in a wine gallon.

28. *Water from the last Discharging Pipe, second Shower Chamber, Metal Calciner Flue.*

10 grains of sulphur, in the state of sulphuric acid.
20½ ditto ditto sulphurous acid.

30½ total sulphur in a wine gallon.

29. *Water from the last Discharging Pipe, in the second large Shower Chamber; beyond the junction of the Ore and Metal-Calciner Flues.*

10 grains of sulphur, in the state of sulphuric acid.
9½ ditto ditto sulphurous acid.

19½ total sulphur in a wine gallon.

THIRD STEAM EXPERIMENT, JAN. 4, 1823. THE WATER EXAMINED BY MR. FARADAY.

Water taken at ten o'clock at night, from the trough of the first chamber, on the Metal-Calciner Flue.

30. Bridge-holes open: no steam. Temp. 76° F.
A wine gallon gave 14 grains of sulphur; as sulphuric acid = 35 grains.
23 grains of sulphur; as sulphurous —— acid = 46 grains.
Total, 37 grains of sulphur.

31. Bridge-holes open: steam on. Temp. 84° F.
A wine gallon gave 18.5 grains of sulphur; as sulphuric acid = 46.2 grains.
25.1 grains of sulphur; as sulphurous —— acid = 50.2 grains.
Total, 43.6 grains of sulphur.

32. Bridge-holes shut: no steam. Temp. 77° F.
A wine gallon gave 55.5 grains of sulphur; as sulphuric acid = 38.7 grains.
24.2 grains of sulphur; as sulphurous —— acid = 48.4 grains.
Total, 39.7 grains of sulphur.

33. Bridge-holes shut: steam on. Temp. 82° F.

A wine gallon gave 15.7 grains of sulphur; as sulphuric acid = 39.2 grains.

25.1 grains of sulphur; as sulphurous —— acid = 50.2 grains.

Total, 40.1 grains of sulphur.

34. *Glass, that had been three weeks exposed to the action of the smoke, at a high temperature, in the Ore-Calciner Flue, in advance of the Shower Chambers.*

Deposit consists of sulphates of copper, iron, and lime; a minute portion of alkaline sulphate; and a little silica and oxide of iron: no arsenic. The silica may be accidental foulness, or it may result from the action of hydrofluoric acid on the glass; I cannot say which. There is but very little action on the glass; and I cannot say, decidedly, it is from fluoric acid: at the same time, fluoric acid leaves so polished a surface, after its action on glass, that it is very difficult, or even impossible, to perceive it has been at work.

35. *Glass from the Metal-Calciner Flue, after three weeks exposure.*

The deposits on the surface, that yield to water, consist of sulphate of copper, iron, and lime, and an alkali (soda) in minute quantity; and there remain, oxide of iron, a little oxide of copper, small quantities of silica and alumine; no fluoric oxide, or trace of its action.

36. *Water from the first Shower Chamber, Metal-Calciner Flue.*—No trace of fluoric acid.

37. *Water from the first Shower Chamber, Ore-Calciner Flue*; gives the most decided indications of fluoric acid.

38. *Water from the second Shower Chamber, Ore-Calciner Flue; taken at the same time as the preceding*; does not give the smallest trace of fluoric acid.

XXIII.—*A Description of various Screw-Mills, invented by the late celebrated* Oliver Evans, *of Philadelphia.*

These mills are intended to break down or reduce pieces of gypsum, or other similarly hard substances, so as to render them fit for being ground to powder by the ordinary mills.

These machines are extremely important in the United States, where they employ immense quantities of gypsum as a manure. They find, that baking the gypsum very much deteriorates those qualities which render it so precious to agriculture. These mills, however, may, no doubt, be applied with equal advantage to break down the baked gypsum also.

In Plate V. fig. 1 represents a vertical section of one of these mills, with its screw placed horizontally; a position which experience has proved to be the most advantageous.

A B is the screw of a machine capable of breaking down 4000 pounds of gypsum per hour: it is formed of a bar of iron (steeled, of course, on its edges), of 5 or 6 inches wide, and one and a half in thickness: the screw is about 12 or 15 inches long, and makes forty revolutions in a minute. Underneath this screw is a strong semicircular grating, D, formed of iron bars (no doubt also steeled on their upper faces): this grating is placed at the bottom of a thick cast-iron hopper. The upper faces of the bars are inclined from A towards B, to prevent the pieces of stone from slipping too easily before the screw, which turns so as to force them towards B. Each bar thus forms a cutter; and the resistance which they offer to the movement of the pieces forward, underneath the screw, causes the pivot at its extremity to press against the steel plate I.

The pieces of gypsum are thrown into the hopper C; and are broken by a hammer, until they are small enough to be seized by, and exposed to, the action of the screw: and, in proportion as the gypsum is broken down, it falls through the bars, into a spout K E, which conducts it to

the *elevator* of the grinding-mill. The bottom of the spout may also be covered with a sieve, which will permit that gypsum only to fall through which has been sufficiently reduced. In this case, the spout F, which is placed underneath the sieve, receives this portion, and conducts it to the reservoir of the elevator.

G H is a fly-wheel on the axis of the screw: this is highly necessary, to regulate its movement, and to overcome, by its *momentum*, the resistance which results from those pieces of gypsum which are either larger or harder than the others; and, at the same time, to render more equal the strain upon the toothed wheels which drive the screw.

Fig. 2, is a section of another mill of the same kind: but here the screw is placed vertically, in a circular hopper, sufficiently close below to prevent the passage of the too-large pieces of gypsum. The lower end of this hopper may be made of thick cast-iron; and be channelled in such a manner, as to prevent the sliding away of the pieces of gypsum intended to be broken up. Or it may be well to form a pivot-hole in a hard stone, to be fixed in the bottom of the hopper; to render the screw dormant; and to make the hopper turn, in its stead, upon the pivot at the lower end of the fixed screw; which, as in this case, it will close the bottom of the hopper: so other holes must be made around it, to allow the ground gypsum to escape through them. We may also work these mills vertically, with the screw placed horizontally at the bottom of a hopper closed below the screw, the screw traversing and acting in pivot-holes affixed to the hollow grinder; and, being connected at one end with the moving power, the motion of the screw causes the gypsum to advance, as it is broken down, towards the opening in one end of the stationary grinder; from whence it passes between the grinders to be pulverized, and escapes at the other end, when sufficiently ground.

I have constructed one of these mills, with which many

thousand bushels of gypsum have been reduced by the power of one man. Here the hollow circular grinder turned upon the fixed screw; and, being considerably larger and heavier, it acted without any fly-wheel. I sold this mill to a person who employed it to grind charcoal for a steel furnace and was highly satisfied with it.

This screw-mill may be readily made in various other forms, and still without changing its principle, or its ceasing to be an excellent machine. The form, however, which is shewn in fig. 1, is, perhaps, the most convenient for bruising gypsum, charcoal, maize in spikes for the nourishment of cattle, colours of different kinds, minerals, bark, &c. It is very cheap; its simplicity renders it highly valuable; it will not require any kind of toothed wheel-work to actuate it; and it is composed of very few parts, and those easily constructed.

XXIV.—*On the Preparation of the Fluoric Acid, and its application to the Etching of Glass. By Professor* SILLIMAN.*

As we have not seen any notice that this powerful acid has been obtained in this country, we will briefly mention that we procured it in full strength, during the late winter; and, comparing it with the account given in the Memoir in the "*Recherches Physico-Chimiques*" of MM. Gay-Lussac and Thenard, we observed, with much satisfaction, that its properties fully justify their statement: not that we think their researches, or those of Sir H. Davy, needed confirmation, but notices of interesting facts by different persons, especially in different countries, are not without utility.

The leaden apparatus, recommended for procuring pure fluoric acid, we have found so liable to fusion; and, besides the failure of the experiment, and the loss of the apparatus, the fumes are so noxious, and even dangerous; that we were induced to resort to the use of vessels of pure

* From Vol. VI. of the *American Journal of Science and Arts.*

silver. For this purpose, an alembic* was made of the capacity of 16 fluid ounces, with a head and tube of the capacity of two and a half; and the tube was made to fit accurately the mouth of a silver receiver, of the capacity of three and a half ounces. The latter (see the apparatus represented at fig. 3 of Plate V.) was made in the form of a bottle, and furnished with a silver stopper, ground so as to fit air-tight; it being intended to serve both as a receiver, and as a containing vessel for the acid; thus obviating the necessity of transferring it to another vessel.

Two ounces of very pure fluor spar were introduced into the alembic, and four ounces of sulphuric acid were added:—there should be no excess of acid, lest it should attack the silver. The whole apparatus was placed under a flue; the receiver was kept cold by ice; and a few live coals being applied beneath the alembic, served to disengage the acid, which was condensed in the receiver, *without the aid of water.*

An ebullition was soon heard in the alembic; and occasionally, there was a puff of dense fluoric acid vapour from the mouth of the receiver, which, to avoid explosion, was allowed to remain a little loose around the tube. We did not measure the acid which we obtained, but judged that it was about one ounce in quantity.

The fumes that occasionally broke out from the apparatus instantly and powerfully corroded some articles of glass that were near; and the contact of them with the skin or lungs was most anxiously avoided. For this purpose, the hands were covered with very thick gloves; and the acid was never poured from the bottle, except under the flue.

Whenever the bottle was opened, a dense cloud of white vapour appeared: and when a drop of the acid was allowed to fall into water, it produced much the same com-

* The alembic was made thick and heavy, and furnished with a silver cap, so that it might be used without its head, as a large crucible.
The cost of the entire apparatus, alembic-head, tube, cap, and receiver, was about sixty dollars.

motion and noise as a red-hot iron, exciting great heat and ebullition. A few drops, placed in a small concave copper dish, instantly inflamed potassium, which burned with a bright light, and was immediately dissipated.

A drop of the acid, let fall into a dry wine-glass, or upon a dry glass plate, promptly corroded and dissolved the surface, with as much energy as sulphuric acid acts on potash.

For the purpose of procuring an acid adapted to the purpose of etching on glass, the experiment was repeated; with this difference, that half an ounce of water was placed in the receiver. This acid, however, proved too powerful for this purpose, as it corroded and destroyed the varnish* used to protect the glass. When it was diluted with three or four parts of water, it acted in the happiest manner. Plates of glass being properly prepared with the composition of bees' wax and turpentine, and surrounded at their edges by rims of the same substance, were perfectly etched in the course of a minute or two. The progress of the corrosion, in the parts denuded by the etching-needle, could be distinctly seen. The same portion of acid, by pouring it from one plate to another, served to etch several in succession; and indeed, with this active agent, even when largely diluted, it is necessary to be very much on our guard, lest the corrosion go too far, and attack the plain parts of the glass.

In this manner, the rich and beautiful picture representing the Oto Council, as delineated in the Atlas illustrating the narrative of Major Long's Expedition, was elegantly etched in two minutes.

We have, for a course of years, tried many experiments upon the etching of glass by the fluoric acid *vapour*, and have usually succeeded more or less perfectly; but we can

* The common *engraver's varnish* is very apt to be destroyed, even by a very weak acid; but we found that the varnish recommended by MM. Gay-Lussac and Thenard, made by melting together common turpentine and bees' wax, formed a perfect protection, while the acid was of proper strength.

confidently recommend *the pure diluted acid,* as being entirely superior in energy, neatness, and ease of management. Although the strong acid is violent and dangerous in the extreme, and should by no means be allowed to touch the skin, either in the fluid or vaporous state, the diluted acid may be managed with ease and safety. Still, a pupil, who incautiously dropped some of the latter acid upon his hand, experienced inconvenience for six weeks—that period having elapsed, before the sore was healed.

It is proper to remark, that whenever the acid was poured from the receiver, the latter was firmly grasped by tongs of a peculiar construction, in order to avoid the danger of having the liquid come into contact with the hand.

XXV.—*On Improved Economical and Portable Boilers.* *By the* EDITOR.

UPWARDS of ten years since, the Editor purchased one of the late Count Rumford's portable tin boilers, for heating *a very small quantity of water* by a spirit-lamp used for shaving, &c. It was about three and a half inches high, and two and a quarter inches in diameter; but this space was chiefly occupied by an inverted tin vessel, forming a hollow space or cavity beneath, to receive the flame of the spirit-lamp, which cavity was two inches high and one inch and seven-eighths in diameter; so that the water was merely contained in a flattened part made on one side of the inverted vessel (to permit the razor to be dipped into the hot water), and in the remaining space around the cavity between it and the sides of the boiler, together with that which could be held above the flat top of the cavity. The flame of the lamp, after filling the cavity, descended, and surrounded the outside of the boiler; being confined by an external casing of tin which descended half an inch below the bottom of the boiler, and surrounded it, leaving a space of about an eighth of an inch wide around the boiler, for the heated air to pass up, which escaped

through a number of holes made around the upper part of the external casing.

The Editor however found that *a very great loss of heat was sustained in this arrangement; as the coat of tin, on the outer casing, melted, and ran down the sides all around.* He then thought of surrounding this casing with another, leaving a space between them, *and thus forming a ring-boiler around the central one,* with the hot air passage, as before. In this way he found *that the same quantity of spirit of wine would heat twice the quantity of water that it did before the alteration was made.* He next filled up part of the cavity with a hollow cone, which was also filled with water; and the lower part of the cone presented itself immediately within the flame of the lamp, and the water in it became hot considerably sooner than the rest of the water.

Finding such advantages to attend these new arrangements, he next had an apparatus constructed resembling that shewn in Plate VI. fig. 1; which is the very reverse of Count Rumford's. In these boilers, a short pipe extends from the inner boiler to the outer one; so that by pouring water into the former, the latter is also filled. Of these improved boilers he made several for various friends, which afforded them great satisfaction.

He frequently employed the lower part or basis of his *pumice-stone furnace**, with a charcoal fire in it, *lodged in a hemispherical cavity only two and a half inches in diameter and an inch and a half deep,* (which fire is readily kindled, by directing the flame of a candle upon the charcoal with a blow-pipe,) in place of the spirit-lamp;—and with great advantages indeed, in respect to economy in the fuel, and the facility of keeping the water hot for any length of time.

This new construction of the boilers also afforded him the opportunity of very commodiously packing in the inner boiler, a tin bottle, to contain spirit of wine for the supply of the lamp, furnished with a screwed cover to its neck, made

* This furnace is described in Vol. I. p. 461.

water-tight; and also of adding a very useful tin cylindrical vessel, three and a half inches high, and two inches and a quarter in diameter, to the apparatus, which is carried (when inverted) in the outer or ring-boiler; over which shuts the shallow vessel shewn upon the top of the boiler in the figure.

The boilers are supported, at a proper height above the lamp, upon three stout wire springs, two of which are shewn: these slide in the space left around and between the inner and exterior boilers, for the heated air to ascend in.

The spirit-lamp is made of tinned copper: it has three cotton-wicks; and, provided the alcohol has a little water in it, they will last a considerable time, without being consumed.

A cylindrical box shuts within the base of the lamp, and is a convenient receptacle to contain the apparatus and materials for obtaining fire and light; such as, either common or German tinder, a steel, flint, matches (either the common ones, or, which are better, cotton threads drawn through melted sulphur), spare cotton wick-yarn for the lamp, a wax candle, &c. The oxygenated matches and acid bottle may also be substituted for the flint, steel, and tinder, with great convenience. The whole apparatus, when shut up close, forms a cylinder less than five inches in height, and only three inches in diameter.

XXVI.—*On an Improved French Economical Cooking Apparatus, made by M.* LEMAIRE.

WE find the following notice of this Apparatus in Vol. VI. No. 2. of the American Journal of Science and Arts: and it was the very great resemblance between its construction, and that described in the preceding Article, which induced us to publish that Article. It would, indeed, almost seem, that one of those, made by the Editor for his friends, many years since, had found its way to Paris, and became the origin of this. At any rate, it is a

proof of the high estimation in which an apparatus of a similar construction is held there; when such eminent chemists as MM. Thenard and Fourier report so favourably on its advantages.

Cooking Apparatus.—MM. Thenard and Fourier made a favourable report to the French Institute, on the 26th of August last (1822), relative to a new boiler (*noveau calefacteur*), invented by Lemaire. It *consists of a grate which contains charcoal, from which the heated air ascends into a space between two concentric cylinders, both of which contain water.*—The water in each vessel is thus heated at the same time; and that in the inner one, being surrounded by another vessel of hot water, will retain its elevated temperature a great length of time. By means of a register, the combustion of the charcoal can be regulated at pleasure. The current of hot air can also be intercepted or left free, as necessity requires. The exterior vessel has but three openings: one at the top, for pouring in water; a second at the bottom, with a cock, for drawing it off; and another, for receiving a bent tube, which conveys the steam out of doors. The exterior vessel does not rise higher than the interior one; but it descends lower, and rests upon the grate.

From an experiment of the Reporters, it appears that one part of charcoal is sufficient to vaporize 9.42 parts of water from the freezing point. Now, according to theory, charcoal can evaporate only 10.8 times its own weight of water; hence it appears, that, taking into consideration the heat communicated to the vessels themselves, the actual loss of heat is only $\frac{1}{10}$, which is very trifling.

The superiority of this instrument for culinary purposes, especially for the preparation of soups, vegetables, &c., is attested by these scientific Reporters; who assert that they intend continually to use it, as it is attended with an economy of time and fuel, an improvement in the quality of the food, and a certainty of success.

XXVII.—*On the Cutting of Hardened Steel, &c. by Soft Iron, without the employment of Emery, or any other Abrading Substances. By Mr.* BARNES, *of Cornwall, Connecticut, U. S.*

IN the Sixth Volume of the American Journal of Science and Arts, just received, we find a communication to the Editor of that Work, from the Rev. Herman Daggett, Principal of the Foreign Mission School at the above place, dated Feb. 3, 1823; in which he informs him of a fact which lately came to his knowledge, and which he judged might be of considerable use in mechanics.

A Mr. Barnes, a cabinet-maker there, made a circular plate of *soft sheet-iron* (a piece of stove-pipe), fixed an axis to it, and put it in his lathe, which gave it a very powerful rotary motion.—While in motion, he applied to it a common file, in order, as he thought, to make it perfectly round and smooth; *but the file was cut in two by it, while itself received no impression.*

He then applied a piece of rock-crystal (smoky quartz) to it, which had the desired effect.

Having occasion to alter a cross-cut saw, *made of a very hard plate*—which would have required considerable labour in the usual way of filing, he applied it under the circular plate, which, *in a few minutes, neatly and completely cut it through longitudinally.*

When he stopped the motion of the circular plate, he found that it had received no wear from the operation, and that he could immediately apply his fingers to it without perceiving much sensible heat. During the operation, there appeared a band of intense fire around it, continually emitting sparks with great violence.

He afterwards marked the saw for the teeth; and, in a short time, cut them out by the same means.

Remarks by the EDITOR.

We have been necessitated to change the original arrangement of this Article, in order to make it agree with the

circumstances of the discovery. We must own, that, at first, we considered it as one of those wonderful tales which our friends on the other side of the Atlantic are so much in the habit of inventing for their own amusement: but, through the kindness of Mr. Jacob Perkins, we have since had the most satisfactory testimony of the truth of the statement, from an experiment just made by him; and have seen a piece of a hard file, which not only had its teeth instantly removed by the action of a circular plate of soft sheet-iron, of six inches in diameter and one-twelfth of an inch thick, against the edge of which it was held, whilst the plate was revolving with very considerable velocity (say at the rate of about one hundred miles per hour), but it also had deep gaps cut in its end, which, at the same time, became softened, by the great heat produced from the friction. Another gap was also cut across the hard part of the file, nearly through it, and without sufficient heat being produced to soften it. The iron plate had been previously made truly round by the turning-tool, whilst moving at a much slower rate; and it was not in the least degree reduced in size by its violent action upon the file: it had however acquired, in Mr. Perkins's opinion, *an exceedingly great, though superficial hardness upon its periphery, from the burnishing action of the hard steel upon it*; which had, he thought, enabled it to act, in its turn, upon the file itself. He is now engaged in making experiments on the application of this important discovery to the Arts; and will favour us with the results, in time for our succeeding Number.

XXVIII.—*Improvement in Laying-down Iron Conduit-Pipes. By Mr.* GEORGE VAUX, *of Philadelphia.**

THE increasing efforts which are making, in this country (N. America), to supply our cities with good water, give a peculiar interest to every thing connected with this subject.

* From Vol. VI. No. 1. of *Silliman's American Journal of Science and Arts.*

One of the principal practical difficulties in these undertakings, arises from the bursting, leaking, and decay of the water-pipes. Many years ago, they were formed of cast-iron in Scotland: and it appears that cast-iron pipes are now in full and successful use in the New-River Works near London. We have before us the Report of the Watering Committee of Philadelphia; which contains an important correspondence between the Committee and Mr. Walker, the Engineer of the London New-River Water-works. We are assured by Mr. George Vaux, of Philadelphia, to whom we are indebted for these facts, that the information communicated by Mr. Walker "has been found, by experience during the last four years, to be most correct and important." It is not possible to do justice to Mr. Walker, without copying his Letters entire. The most important results, however, are, that cast-iron pipes of any necessary diameter, even to two or three feet, may be employed;—that their strength is sufficient to resist any desired pressure, when the thickness of their sides is very trifling; three quarters of an inch being sufficient for pipes of twenty inches diameter; three eighths of an inch for ten inches; and three sixteenths for a five-inch pipe;—that the pressure, with a head of one hundred and forty feet, is about sixty-two pounds on the square inch, "which is much less than one-tenth of the pressure which a good casting, of one foot diameter and half an inch thick, is capable of resisting; the tenacity of a square inch of the best cast-iron having been found, by experiment, to exceed twenty thousand pounds;"*—that the joints of the pipes can be rendered impervious and secure;—that the iron is very durable—imparts no disagreeable taste to the water—is, when properly prepared, always to be depended on—and, in the course of years, is more economical than any other substances.

* The proof of these pipes and cocks is made by the hydraulic press and those sent out by Mr. Walker to Philadelphia were proved by a pressure equal to a column of water of three hundred feet in height; that is, of the weight of nine or ten atmospheres.

The joint used in London, for connecting the pipes, is the spigot and faucet; made tight, in some cases, by lead cast around; and in others, by a cement, which is composed of two pounds of sal-ammoniac, one hundred pounds of borings of cast-iron, and a little sulphur. These materials are mixed with water: "the iron is oxidized; and, in a short time, the mixture becomes extremely hard, and quite impervious to water."

When lead is used, it is contracted by cooling; and it is necessary to *upset* the joint, with a hammer and chisel.

The following extract of a Letter to the Editor, dated December 25, 1822, from Mr. Vaux, contains much valuable information:—

"Our experience I consider to be decisive, especially in relation to the all-important matter of the joints of the conduits.

"The pipes, of whatever size, are usually cast in lengths of nine feet; and are always so laid, as to have a covering of earth, at least four feet thick. During the last three or four years, about thirty thousand feet have been put down by the city of Philadelphia, and between three and four thousand joints have been made. The pipes vary in diameter, from twenty-two to two inches; and in no single instance has there appeared any difficulty from the change of temperature, or, in fact, from any other cause; although our head of water, in the highest part of the city, is sixty feet; and, in the lower parts, near ninety—the pressure of which is never removed.

"In making the joints, the directions of Mr. Walker are pursued; but our workmen, *instead of stopping the opening between the pipes with clay only*, previous to pouring in the liquid lead, clasp the *inserted* pipe with *an iron ring*, composed of two semicircles of thick hoop-iron, bent edgeways, and united, on one side, by a joint or hinge, and, on the other, by a thumb-screw. This ring, being placed directly against the end of the *receiving* pipe, covers the space between the two pipes; and the clay is then applied over it. *When the lead is poured in, the surface next to the ring will*

be smooth all around; and the troublesome operation of chipping and dressing is entirely saved.

"The persons engaged in making the joints have acquired such confidence in their work, that they no longer deem a proof necessary; but fill up and puddle the trench, before the water is turned into the pipes.

"The information now possessed, I consider of great importance, not only to our city, but to the country at large; as, without it, iron could not be used for conduits; there being, I believe, no other effectual mode of securing the joints: in fact, a knowledge of this matter, twenty years ago, would have saved us at least 100,000 dollars. When the water-works were first erected by Mr. Latrobe, he put down about a mile of iron pipe; but, from the contraction, it was found not to succeed. Various attempts were made to obtain information from England; all of which failed, previous to the application to Mr. Walker.

"Our new water-works are not upon the plan recommended by Mr. Walker, though some of his recommendations have been adopted. There is no description of them in print; and I cannot personally furnish you with answers to your inquiries at this time. In the course of a few weeks, I hope to be able to do it satisfactorily."

XXIX.—*On the Philadelphia Water-Works.**

THIS fine city is now abundantly supplied with good water, from the Schuylkill; and a magnificent establishment, for that purpose, is completed at Fair Mount, five miles above the city, at the Falls of the Schuylkill. The entire expense, including the purchase of the site, is 426,330 dollars; but the money appears to have been well bestowed, as the success of the experiment is complete. The river at the Falls is about nine hundred feet wide; the depth, at high water, is thirty feet; its average rise and fall is six feet; and it is liable to sudden and violent *freshets*. "The whole length of the over-fall is one thousand

* From Vol. VI. No. 2, of *Silliman's American Journal of Science and Arts.*

two hundred and four feet; and the whole extent of the dam, including the western pier, about one thousand six hundred feet;" backing the water up the river, about six miles.

The water-power created is calculated to be equal to raise into the reservoir, by eight wheels and pumps, upwards of ten millions of gallons *per diem.* The river, in the dry season, will afford four hundred and forty millions every four and twenty hours; and it is calculated, that *forty gallons upon the wheel* will raise *one* into the reservoir. Eleven millions of gallons may be raised each day.

Many interesting particulars detailed in the last Report of the Watering Committee, and which is forwarded to us by the kindness of Mr. George Vaux, illustrated by a large copper-plate sheet exhibiting a plan and perspective, we must omit; and proceed to state, that the machinery in actual operation is able to raise upwards of four millions of gallons in twenty-four hours, into the reservoir; which is of such an elevation, as to afford the hydrostatic pressure of ninety-two feet, throwing upon the pumps a pressure of seven thousand nine hundred pounds. There are two reservoirs; one of which is one hundred and thirty-nine feet, by three hundred and sixteen, and twelve feet deep; having the capacity of three millions of gallons: it is connected with another reservoir, which contains four millions of gallons. The water being raised into these, one hundred and two feet above low tide, and fifty-six above the highest ground in the city, is thence conveyed *in the iron pipes described in the preceding Article; the whole extent of which is now thirty-five thousand two hundred and five feet;* "*and in no instance has a leak been discovered.*" The greater part of the pipes now laid are of American manufacture; none ever having been imported, except as samples.

The system obviously admits of indefinite extension. The Committee justly remark, that "the uses and importance of this water it is impossible sufficiently to value. The additional cleanliness of the city (which, with the suburbs, contains between 120,000 and 130,000 people)—the supply of the neighbouring districts, for culinary purposes, as well as

for purposes of refreshment—the great advantage in case of fire—the ornament of fountains in the public squares, so wisely provided by our Great Founder—the benefit to manufactures—and *the establishment of water-power in the city, for various purposes,* may be named among the advantages of this new work;—but, above all, we are to place its effect upon the health of a great and growing community; which, of itself, would justify a much greater expenditure."

XXX.—*On Bronze Statues, and Medals; and on Cannon, Bells, &c.*

[Continued from p. 139.]

It appears, that if the moulding and casting, according to the principles we have described, be well executed, the dies are not sooner injured than in the manufacture of medals in pure copper: in fact, most of the first experiments of M. de Puymaurin were made with old dies, already cracked in coining copper medals; and none of them were broken, although the alloy employed contained 17 hundredths of tin.*

It appears evident, indeed, by all the preceding observations, that the manufacture of *bronze* medals will no longer present any real obstacles, and that M. de Puymaurin has solved this important problem in the numismatic art. His Memoir will soon be presented to the Institute, and a Commission named to examine and confirm the probable results of his experiments, and appreciate their utility: their Report will determine the employment, or otherwise, of this new mode of manufacture.

* M. de Puymaurin, being required to manufacture 1000 medals of 22 lines in diameter, of bronze containing 10 hundredths of tin, which were to be given to the ladies in the Hall at Bordeaux, by the Duchess of Berry, had a steel die sunk for the purpose:—this, after having afforded *fifty medals in copper,* required agreeably to the bargain made with the engraver, became cracked; and it did not appear probable that it could stand the manufacture of the 1000 medals in bronze: nevertheless, pressed by the exigency of the moment, he endeavoured to make it serve; and the 1000 medals were finished, without the crack appearing to extend itself in any degree.

Bronze for Bells.—This, which is known under the name of *bell-metal*, is composed of various proportions, of copper, tin, zinc, and lead; and, accidentally, of iron, bismuth, and silver. It has been pretended that this latter metal must necessarily enter into the composition of bells, and particularly of large bells: many persons still think, that, without it, the sound would not be so clear, nor so pure: from this, perhaps, is derived the expression of its '*silver sound*.' The facts, on which this error is founded, are sufficiently curious to be related here; and very clearly prove that such an opinion is ill founded.

The ancient custom of baptizing bells, and giving them a godfather, is well known; and, besides the honour of holding the bell at the baptismal font, which was an important part of the ceremony, and generally conferred on a Prince, a Lord, or some other person of distinction, he was permitted to plunge into the furnace, with his own hands, the silver which was given to improve the sound of the bell: the ladies of the place were likewise permitted to concur in this result, by adding some pieces of their own plate. Would any one believe, that, after all the publicity given to this operation, there was no more silver found in the bell when finished, than was originally in the metal furnished by the founder? This, however, was actually the case; and, probably, accomplished in the following manner:—The hole at the top of the furnace, destined to receive what silver might be brought, was made directly above the grate; and this part of a reverberatory furnace, as we know, is separated from the floor of the furnace, on which the metals are brought into fusion, by the bridge of the furnace: the effect of this position of the hole (by which the fuel is also introduced) is, that the whole of the silver, instead of being really introduced into the fused bronze, falls directly on the grate; and, after fusion, to the bottom of the ash-pit, where the founder does not fail to seek for it, after the operation, to employ it more usefully than in clearing the sound of the bell.

In the manufacture of bells, the only useful metals, in the composition of the alloy, are copper and tin, in the following proportions:

Copper	78
Fine Tin	22
	100

This alloy possesses a fine and close grain, is very fusible, and exceedingly sonorous: the other metals which are generally added have no other known utility, than that of diminishing the price of the alloy, and, consequently, augmenting the profits of the founders. As for the purity of the sound in a bell, it is not a very important matter; but, whenever this is particularly required, we cannot do better than to adopt the proportions above indicated. In fact, the above alloy is not different from that of other sonorous instruments, as we shall presently shew: it produces excellent sounds, provided that all the other conditions necessary to this result have been carefully observed. The form is one of the most essential of these conditions: it is also requisite that the fused bronze be perfectly homogeneous in all its parts, that it may neither contain air-holes nor scoriæ; and that it be poured sufficiently fluid for all parts of the mould to be well filled, so that it may present a perfectly uniform surface. (See, at the end of this Article, the general instructions in regard to bronze.)—The English bells are composed, according to Dr. Thomson, of copper 80; tin 10.1; zinc 5.6; and lead 4.3. This alloy is inferior to that for cymbals, the quantity of lead being too considerable; as, in such proportions, isolated points always form, which destroy the homogeneity of the alloy, and injure its vibrations.

When, during the Revolution, statues, inscriptions, and bells, were converted into cannon, money, &c. they used to extract those metals, the quantity and value of which were least considerable, in order to procure the copper and tin separately; and finally, to treat the scoriæ by pro-

cesses which deserve to be made known, and which have been particularly applied to bell-metal: but these processes are also applicable to the treatment of bronze in general; and, consequently, will be found in the general instructions, at the end of this Article.

Gongs, Tam-tams, and Cymbals, of Bronze.—The Chinese use instruments of bronze, formed with the hammer, very thin, and in the form of discs, with a rounded protuberance in the middle; which they call *tam-tams, gong-gongs* (from *tshoung*, which, in Chinese, signifies *bell*). Barrow, in his "Voyage to China," says, that a very shrill sound is heard at a great distance, when these instruments are struck with a stick covered with a ball of leather; and that their composition consists of copper, tin, and bismuth. Klaproth has shewn, that they contain only copper and tin: the proportions indicated by him, are, copper 78, and tin 22; their specific gravity is 8.815. This alloy is extremely brittle, and we are ignorant in what way the Chinese can render it so ductile as to be forged with the hammer. The result of the experiments which M. Darcet has made upon these instruments, proves, that the bronze of which they are formed, and which is cast into thin plates, and as brittle as glass, becomes ductile, if heated and plunged into cold water: he has made this singular effect, of *tempering* the bronze, the basis of various new arts, and, particularly, the manufacture of cymbals and gongs. To manufacture these, the bronze is cast in a mould; the cast pieces are heated to a cherry-red, and plunged into cold water; being held firmly between two flat plates of iron, that they may not be put out of shape, in tempering: and they are finished, by given them light blows all round.

The mean analyses, of 22 cymbals and 4 gongs, have afforded the following results:

Cymbals	copper	80	Gongs	copper	78
	tin	20		tin	22
		100			100

Vessels of Bronze.—Among the antique bronzes, there have been found, as before stated, various vases and culinary utensils, which were in use among the Ancients. Vessels of this kind are still in use; but the brittleness of the bronze rendering it necessary to give a greater thickness to these articles, they are very inconvenient to use, on account of their weight. M. Darcet, however, in bringing into action the property which bronze presents, of becoming ductile by heating and quenching, has manufactured vessels sufficiently light, and easy to be tinned. This application, though recent, may produce a new species of manufacture.

Mortars of Bronze.—These mortars, which are useful on account of their hardness, still possess the very serious inconvenience of being brittle on their edges. As this part is thin, and subject to break,—and as it is not necessary for it to possess the hardness of the bottom of the mortar,—this inconvenience may be remedied, by heating the mortar red-hot, and cooling this part only, in water.

Tools and Ancient Weapons, of Bronze.—Opinions have long been divided, on the means which had been employed to give these articles the hardness which we know them to possess. Some supposed that this property was the effect of iron purposely alloyed with it: others have attributed it to silver, bismuth, &c. In fact, the presence of these metals has been demonstrated in some antique bronzes; yet, as they are not constant, nor in the same proportions, and as there has not been found any sensible quantity in several recent analyses, it is most reasonable to conclude that they may be in it accidentally; and that tin, as demonstrated by every analysis, was the only metal added, to harden the copper. (Dizé, *Journal de Phys.*, April 1790.)

Pliny, in describing the composition of the ancient bronze, in his *Hist. Nat.* lib. xxxiv. cap. 9, says, that they alloyed 100 of copper with 12½ parts of tin for fine works; and that they only added from 3 to 4 of tin to 100 parts of copper, for articles of less importance.

John Christian Nieglib, in 1777, presented to the Academy of Sciences at Mayence, a great number of analyses of bronze, produced from different ancient weapons found near a village three leagues from Langensalza. He concludes, from his assays, that these alloys were made in the proportions of 3.50; 5; 5.50; 12, and 14 of tin, to 100 of copper: and although a very remarkable quantity of silver has been found*, and even a little gold, he does not imagine, however, that these precious metals were put in designedly: he says, it is probable that they remained in the bronze, because the art of perfectly separating those metals was not so well understood then, as in our day.

Among the various tools or arms of the Ancients in bronze, the greater part were hard and brittle; but some were ductile, and appeared to have been softened by *tempering*. All that we have before stated, proves that their composition, although extremely variable as respects the proportions of the alloyed metals, generally consisted of copper and tin. The following analyses, principally made in the laboratory belonging to the Mint, also demonstrates this:—

An antique sword, found in 1799, in the turbaries at Somme. Copper 87.47; tin 12.53.

Springs of bronze, for the ancient balista; containing, according to Phylon of Byzantium, 97 of copper, and 3 of tin.

Hard and brittle nails. Copper 92; tin 8.

Three swords, found in the environs of Abbeville: the first contained, copper, 85 tin 15.

The nails in the handle of this sword were flexible; and were composed of, 95 of copper, and 5 of tin.

The second sword; copper 90; tin 10.

The third; copper 96; tin 4.

* 25 ounces in the 100 pounds, which is more than the 0.015th part of their weight. This quantity of silver appears very extraordinary; M. Darcet having never found any sensible quantity, in the numerous analyses which he has made of antique or Roman bronzes.

A fragment of an antique sickle; copper 92.61; tin 7.39.

A large flexible ring; copper 91; tin 9.

Among the utensils of bronze used by the Ancients, razors, knives, &c. have been found: but for these purposes, iron and steel are, in general, far preferable to bronze; this alloy not being at all applicable to cutting instruments.

We shall now treat of a more interesting application of bronze; namely, in manufacturing pieces of artillery.

Bronze for Cannon.—Since the time of Birringuccio, who, in 1750, published a work on pyrotechny, in which he spoke of the fusion of metals, the various authors who have written on artillery have mentioned a multiplicity of experiments made with all the intermediate alloys, from 4 to 20 of tin, to 100 of copper: but amongst all these experiments, they sought in vain for a positive result; although they met with many very contradictory ones. It appears that these anomalies were chiefly owing to irregularities, in the fusion, the mixture, and the moulding and casting of the bronze: in fact, the best alloy may become the worst, if it be not perfectly homogeneous in all its parts; and if it contain air-holes, however imperceptible; owing to the gas, which, not being completely liberated from it in casting, has re-acted on the bronze whilst fluid, and lodged in it; thus rendering it porous. Accuracy then, in every process of the manufacture, is the first thing to be desired; and this, without doubt, consists in the mode of directing the operations in the foundries*.

An alloy easily rendered homogeneous, and which may be cast without trouble, of a tenacity sufficiently great not to break, and yet hard enough to resist the friction of the

* We know that the engineers appointed to superintend the foundries cannot always be there; and not having had time to acquire a mechanical education, can never attain confidence, or even a hope of perfecting an art, which, indeed, they must soon lose sight of, when the Government calls them to other employments. Would it not be preferable to establish an especial department for the employment of mechanical engineers?

projectiles; and, finally, so little fusible, as not to be altered during a very brisk firing of red-hot bullets; presents all the properties desirable in the bronze for cannon. The various alloys proposed, unite, more or less, the greater part of these conditions. We will endeavour to describe them.

Our Government, in 1769, prescribed, in a Note on the 3d Article of Instruction, of the 31st of October, the following composition for all sorts of brass cannon:—

Copper	100	or about	Copper	90.91
Tin	11		Tin	9.09
				100.

This alloy, when it is well made, appears to unite all the conditions we have above indicated: it is of a yellowish colour; of a greater density than the mean of the two metals composing it; tougher, and more fusible than copper; slightly malleable, when cooled slowly; and becomes exceedingly malleable by *tempering*, &c. If it does not present all the advantages of the best possible composition, it is at least superior to those which have been substituted for it, in consequence of the ill execution of the law in our foundries. Experiments made by assaying Spanish cannon which have been fired upwards of 6000 times, in comparison with others which have only withstood from 300 to 1000 firings, sufficiently demonstrate this assertion.

Assays were made at Turin in 1770, (as related by General Papacino d'Anthony,) the result of which was, that the most convenient alloy, for cannon of a large calibre, was composed of from 12 to 14 of tin, to 100 of copper.

The Count Lamartillière has published experiments made at Douay, in 1786, on the alloys of 5.4; 7.6; 8; 8.3; 9.3; and 11, of tin, with 100 of copper; the result of which was, that not less than 8 parts of tin to 100 of copper should be employed in the bronze for cannon; nor more than 11.

Nevertheless, M. Briche, who has very carefully ob-

served the operations in the foundry at Strasbourg, has announced, (*tom.* VI. *du Journal des Mines, p.* 879,) that the best proportions of the alloy for good pieces of cannon were not yet determined. He doubtless did not regard the experiments made at Turin and Douay as conclusive.

A Commission, composed of MM. Daboville, Darcet, Depommereul, D'Hennezel, Gilet, and Baillet, named to examine the complaints of the Generals-in-chief of the army of the Rhine, in 1797, declared that new experiments on the composition of cannon were indispensably necessary.

Another Commission, composed of MM. Songis, Andréossy, Laribolssière, Ruty, and Daboville, attributed the destruction in the large cannon, not to the alloy, which they supposed to be composed of from 8 to 10 parts of tin in the 100, but to the imperfect mixture of the metal in the furnace, and to the metal cooling too slowly in the moulds.

We are then but little farther advanced, since 1418, in the knowledge of the best composition for bronze: and the variations we have observed in the alloys of foreign cannon* are still greater than among us. Various authors are not agreed on the necessity of introducing a great quantity of tin into the bronze intended for large pieces of battering cannon, such as the 24- and 26-pounders; because they ought to be capable of resisting the effects of large balls upon their bores, during a long siege. According to M. Shlie, the most convenient proportion of tin is about 14 hundredths†. The English employ, for this purpose, CAST-IRON; and find it answer well. We know, in fact, that cast-iron is harder than bronze; and that it possesses sufficient strength, when it has been well manufactured, to resist the explosions of the charge, par-

* The composition of their cannon varied from 8 to 12 hundredths of tin.

† We know that the hardness is in the direct ratio of the quantity of tin in the bronze; and that its tenacity is in the inverse ratio of this quantity.

ticularly in cannon of a large calibre which are fired slowly; and, finally, that, in consequence of its hardness, it is more capable of withstanding the friction of the projectiles, than bronze.

MM. Feutry and Gassendi have proposed to line the bores of cannon with iron. We owe to M. Ducros the discovery of the method of soldering bronze to iron, by tinning it. It appears to us, nevertheless, that the difference of expansion in the metals will probably soon separate this union, and that it is preferable to employ iron alone.

M. Darcet attempted, in the small way, to alloy iron with bronze, and with good success: he thought that the ternary or quaternary alloys (into which there entered only an hundredth part of lead) might be usefully employed in the manufacture of cannon.

M. Dussaussoy made a great number of experiments, to ascertain if it would be advantageous, in the manufacture of cannon, to alloy the ordinary bronze with iron and zinc: the result of his labours proves, that in 100 parts of alloy we can only add 1, or 1.5, of tinned iron, or 3 of zinc, at most; and that it was much better to use iron already united to tin (tinned-iron), than pure iron, on account of the facility of combining it. These alloys always present the inconveniences of decomposing in the recasting, either from the separation of the iron or the zinc: and the combination of the iron requires the greatest care, as the least accident may spoil it (see the general instructions at the end of this Article); whilst with the alloy, made in the proportions prescribed by the law, we always experience good results and identical products, provided that the operations have been well directed: and we here again repeat, that it is of the utmost consequence to direct and regulate the operations in our foundries.

Gilt bronze, Or-molu, or Bronze Ornaments.—M. Darcet, in a very interesting Memoir on the means of defending water-gilders from the dangers of mercurial vapours,—a

Memoir which gained the prize bequeathed by M. Ravrio, late one of our most distinguished manufacturers in *bronze* (see our article on *Assainissement*, vol. III. p. 92), has published some very useful instructions to the manufacturers of gilded bronze *(Or-molu)* ornaments; and we shall here extract what relates to this subject.

The manufacturers send to the founder, models of the pieces which they wish to have cast. The latter, guided only by the experience of long practice, generally employs old bronze, from which the gold has been removed; which is what is called *mitraille pendante*, or old metal. He uses it alone, when he supposes it to be of a good quality; but he also frequently employs various old articles of other metal, for the same purpose; such as old candlesticks, &c.: in fact, for this purpose, he buys old brass, of all kinds to be found in commerce.

If the old bronze which he has procured be not of a good quality, he adds to it, in order to render it *softer* or *harder*, copper, zinc, or tin. If he has only old brass, or tinned copper, such as old pots or saucepans, he casts his pieces therewith, in those proportions which appear to him to be right: he afterwards judges, by the *grain*, of his mixture; of which he pours out a small sample, and allows it to cool, in order to examine it when broken. If he finds that the grain is fine, and perfectly homogeneous in all parts, and has a proper colour, tenacity, and hardness, he concludes that the quantities are correct. But we may well conceive that these appearances afford extremely vague results; and that it is impossible, from the circumstances by which it is guided, that they should be always identic. It is, however, an essential requisite that the bronze should always possess the following qualities.

Bronze intended to be gilt must be easily fusible: it must perfectly receive the impression of the mould in which it is cast. The casts must neither have *roughness*, *air-holes*, nor *cracks*: the alloy must be capable of being readily turned, chiselled, and burnished: it must possess

a fine tint, and easily take the green colour of the *patine antique** : it must also take the gold readily, and without absorbing too great a quantity of the amalgam: finally, it is requisite that the gold should adhere well to it, and take a good colour, whether it be *matted* or *burnished*; the colour of *Or-molu*, or *Or-rouge*.

There is no pure metal, of any kind, which unites in itself all these properties: in fact, iron can scarcely be used at all for this purpose; as is readily seen, from the above enumeration of the properties requisite for the manufacture of these articles: tin, lead, and zinc, would be too soft, and too susceptible of alteration. Copper, alone, possesses some valuable qualities; but it would be difficult to cast, and is too *pasty*, in fusion, for the founder; too *tough* for the chiseller and turner; would require too large a quantity of gold; &c. (See the following Table, p. 181.)

The alloy of copper and zinc would be preferable: but the results No. 2, in the Table above referred to, prove that this binary alloy is pasty, and does not receive well the impression of the mould; that it absorbs too much amalgam, is subject to indentations and cracks in cooling, and too tough to be turned and chiselled; and, finally, that if the proportion of zinc be increased, to render it harder, it loses the yellow colour preferred by the gilder.

The assays under Nos. 3 and 4 of the Table will shew that the alloy composed of 20 parts of tin with 80 of copper fuses easily, runs fluid, and perfectly receives the impression of the mould: but this alloy, whether it be *tempered* or not, is not easily cleaned by acids; is too hard

* The green tint which we call *patine*, and to which the Romans gave the name of *æruga*, is acquired by time. The Corinthian metal possessed a beautiful light-green colour, the appearance of which resembled the green moss upon trees (*mucor furfuraceus*). It appears that the metals, composing the bronze, change, to form this coloured coating, in proportion to their relative quantities in the alloy.

The *patine* formed by the action of the oxygen and carbonic acid in the atmospheric air, aided by its humidity, and assisted by the action of the winds, is found to contain oxygen, carbonic acid, copper, tin, zinc, alumine, silex, lime, and some traces of lead.

and brittle to be easily turned and chiselled; is of too grey a colour; takes the gold with difficulty; and can only be polished by a long-continued use of the burnisher: this alloy, therefore, is not suitable for *Or-molu* or gilt bronze.

The alloy No. 5, in the same Table, containing 10 hundredths of tin and 90 of copper, is the bronze for cannon. It fuses easily, and becomes sufficiently liquid; but it does not easily penetrate all the finer parts of the mould. It is easier to turn, chisel, and burnish, than either of the preceding alloys; but it is not yellow enough, requiring a greater quantity of gold in order to obtain those shades of colour required for sale*.

Not any of these alloys, then, are applicable to the manufacture of *Or-molu:* and as we have shewn that pure metals cannot be employed for this purpose, we must have recourse to other metallic combinations more complicated than the binary alloys: we are thus naturally led to seek for such a composition as the founders prefer, but which they are never certain of obtaining. We have shewn that they generally alloy 25 hundredths of tinned copper, probably containing some solder, with 75 of brass. According to the composition of the brass, the tinned copper, and the solder†, the bronze obtained must be composed nearly as follows:

* We know that it requires much more gold to *cover* the surface of bronze, when its colour is less yellow. Alloys of copper and tin, only, would be cleaned with difficulty by the methods in general use: in fact, the nitric acid would oxidate the tin; the surface of the bronze would present a greyish tint, which must be removed by the muriatic acid; and the *tempering*, which renders these alloys more ductile, could not, in this case, be advantageously employed, as it would render this alloy too permeable by the amalgam.

† The brass found in commerce, and the tinned copper, loaded also with solder, contain, on an average, in the quintal, the following proportions:

Brass	Copper	63.70	Tinned Copper	Copper	97.
	Zinc	33.50		Tin	2.5
	Tin	2.55		Lead	0.5
	Lead	0.25			100.
		100.			

See *Annales de Chimie et de Physique*, tom. V. *Chaudet; et Annales des Mines*, tom. III. *Berthier*.

Copper	72.
Zinc	25.2
Tin	2.5
Lead	0.3
	100.

In fact, M. Darcet has found, in a great number of experiments on *Or-moulu*, that it was composed of a quaternary alloy; some contained, perhaps accidentally, iron, antimony, gold, and silver, but in small quantities. The Table contains the results of these analyses; and we have shewn that the Brothers Keller, celebrated founders in the reign of Louis XIV., preferred the quaternary alloy; as has been proved by an analysis of their fine statues.

It appears, then, that the quaternary alloy of copper, zinc, tin, and lead, is the best for casting sculptured or other bronze ornaments*. It is necessary to fix the proportions to be adopted; and thus point out a certain plan for the founders.

M. Dussaussoy has clearly shewn† that an alloy of 80 hundredth parts of copper, 17 of zinc, and 3 of tin, is preferable to all others for manufacturing the furniture of fire-arms, as it possessed the greatest tenacity, malleability, hardness, and density: but as density is, of all these properties, the most important to be given to bronze intended to be gilt‡, M. Darcet thinks that, in this respect, the most preferable composition for bronze may be deduced from the interesting work of M. Dussaussoy; and that it may be found among the quaternian alloys rejected by this

* The analyses of a piece of *gilt copper* or bronze from China, and of another from Berlin, convinced M. Darcet that the former contained only copper, zinc, and lead; and the latter, copper and zinc. All the laminated pieces gilt in France are composed of copper and zinc: these exceptions are often necessary, according to the nature of the work.

† In *Annales de Chimie et de Physique*, tom. V. pp. 113, 225.

‡ The first of these two alloys forms No. 7 of the following Table. The results there explained, indicate, in a positive manner, that bronze, so composed, is proper to receive any fashion which may be desired to be given to it.

author (with respect to another employment of it), and is composed of:

Copper	82.
Zinc	18.
Tin	3. or 1
Lead	1.5 or 3

In a composition where lead is in a greater proportion than tin, the tenacity is diminished, and the density augmented; which is preferable for pieces of small dimensions*.

We find in the first volume of the *Déscription des Brevets d'Invention*, a note, in which M. Léonard Tournu publishes the composition of an alloy which requires but two-thirds the quantity of the gold used with ordinary alloys: this bronze is composed of 8 parts copper, 1.5 of zinc, and 1 of brass: from whence it follows, that it must contain, in the 100,

Copper	82.257
Zinc	17.481
Tin	0.238
Lead	0.024

This serves to shew, that the quaternary alloy is preferable for all pieces which are to be gilt, and to prove the advantage of the compositions above cited; among which we are left to choose, because it must depend on the use we intend to make of the bronze.

The founders then prefer it, when all its parts are homogeneous. They endeavour to obtain the desired end, by

* We have before stated, under the head of "*Medals in Bronze*," that the density of bronze is increased a seventeenth part, by increasing the proportion of tin from 5 to 20 hundredths. The hardness and impermeability of this alloy, besides the important applications above stated, are likewise very useful in the manufacture of PUMPS and COCKS.

Mr. Perkins has succeeded, by means of a perfectly-bored cylinder, in a massive block of bronze, to effect a pressure of 2000 atmospheres: he has shewn, by this enormous pressure, that water is compressible and elastic; a fact, till then, unknown. It is certain that, by a less pressure, water has passed through very thick cast iron, as in the hydraulic press; and likewise that mercury has been forced through cast iron, under the pressure of several atmospheres.

preserving, for comparison, an alloy made of all the pieces: but those who are better informed, obtain it with greater certainty, by forming their alloy of pure metals; as is now practised in the Manufactory of Arms at Versailles: and if, with a view to profit from the low price of old metal, they would wish to mix it with the composition of their bronze, they should ascertain its quality, to be able to calculate beforehand the mixtures they must make, in order to bring the bronze to the proportions above described: they should then cast an ingot, from which they may verify its quality.

The following Table indicates the results of comparative experiments, made on pieces of pure copper, and on copper alloyed in various proportions with zinc, tin, and lead.

	No. 1.	2.	3.	4.	5.	6.	7.
Copper	100.	70.	80.	80.	90.	63.70	82.
Zinc	. .	30.	. .	. .	. .	35.55	18.
Tin	. .	. .	20.	20.	10.	2.50	3.
Lead	. .	. .	. .	. .	. .	0.25	1.50
	100.	100.	100.	100.	100.	100.	100.
Specific gravity =	8.700.	8.443.	8.940.	8.920.	8.780.	8.395.	8.215.

	No. 8.	9.		10.		11.	12.
Copper	64.45	70.90	72.43	70.19	69.87	91.40	82.25
Zinc	32.44	24.05	22.75	26.21	26.95	5.53	17.48
Tin	0.25	2.004	2.87	1.41	1.53	1.70	0.24
Lead	2.86	3.05	2.65	2.16	1.65	1.87	0.24
	100.	100.	100.	100.	100.	100.	100.
Specific gravity =	8.542.	8.392	8.275.	8.249.	8.262.	. .	. .

The copper No. 1, and the above alloys, were tried by a founder, a chaser, a turner, and a gilder.

No. 1, according to the report of the first, was difficult to melt, and poured thick: according to the second, it was

too soft, and dogged under the tool: the third agreed with the second: and, finally, the gilder thought that it required too much gold.

No. 2, in the opinion of the same artists, was too pasty when fluid; good, but rather *soft*;—*idem*, good.

No. 3.—Indicated in the same order, the opinions of the same persons appear to be;—Very easy to cast, and *sufficiently fluid*;—very bad;—dry and brittle, and too hard to be cut;—of a bad colour, difficult to cleanse, presenting too much difficulty in the application of the amalgam.

No. 4.—A little better than the preceding;—*idem*—*idem*: the same observations as on No. 3. This alloy is the same as No. 3, but it had been softened by *tempering*.

No. 5.—Pours with some difficulty;—tolerably good;—*idem*;—a bad colour, but otherwise pretty good.

No. 6.—A good alloy;—*idem*;—*idem*;—very good, and of a fine colour.

No. 7.—A very good alloy;—*idem*;—*idem*;—very good, and of a fine colour.

No. 8.—A very good alloy; as agreed on all hands.

No. 9.—These two alloys were sent from M. Darcet to M. Dussaussoy, as bronzes that Mr. Thomire had found to be very good.

No. 10.—These alloys were reported as being very bad.

No. 11.—Analysis of the bronze made by the Brothers Keller.

No. 12.—Alloy proposed, or invented, by M. Léonard Tournu.

The pieces cast of Nos. 1, 4, and 5, are those that absorbed the most amalgam: they were cast in copper; an alloy of copper and tin; those which had been submitted to the *tempering* process; and gun metal:—this exactly agrees with the opinion of the gilders. With respect to the quantity of amalgam to be employed, the gilder may indifferently use, either pure copper, or almost any of the alloys of copper, with tin, zinc, or lead. We see by the above experiments, that what best suits the founder, does

not always suit the chaser and the turner. The burnisher must also, like the others, find certain properties in the alloy which he uses. We must then, as we have before recommended, choose an alloy possessing the most desirable properties, and make use of the means pointed out for obtaining it constantly identic.

A bronze colour is given to figures, and other articles of bronze, by the following process:

Dissolve *2 gros* (or *76 centigrammes*) of sal-ammoniac (muriate of ammonia), and half a *gros* (or 19 *centigrammes*) of salt of sorrel (oxalic acid), in half a pint (about 400 *grammes*) of double distilled vinegar (diluted acetic acid). Slightly moisten a hair-pencil or brush with this solution, squeezing it after dipping, so that as little as possible may remain in it; rub briskly with it, in the sun or over a stove, the *well-cleansed* metal, until the pencil becomes dry. Repeat this operation until the desired shades of colour are obtained.—The first coating produces a greenish yellow-brown colour; the second, a green-brown bronze; and, by a repetition of these coatings, shades may be obtained so dark, as to appear completely black.

We shall finish this Article by giving some general instructions for the manufacture of bronze, and the best means which can be employed in mixing the metals together which compose it, so as to prevent the oxidation or volatilization of any of them, that their relative proportions may not be changed, and the least loss be sustained: we shall then point out the treatment of the dross and scoriæ; and, finally, shall describe the analytical processes, more or less easy or difficult, which chemistry affords, to ascertain the proportions of the metals which enter into the composition of bronze. This knowledge is highly useful to the manufacturers of bronze in ingots; and to all other founders in bronze, whose operations are not directed by practical chemists.

We have sufficiently explained the advantages and in-

conveniences of the various compositions of bronze, as respects bronze statues, medals, bells, cymbals, and gongs; as well as various other articles, such as weapons, cannon, pumps, cocks, and ornaments in *Or-molu.*

We have described, in that part of this Article "*On medals in bronze,*" some remarkable circumstances which take place in the fusion of bronze in the crucible: but we will further add, that whenever zinc is mixed with other metals, it must be stirred in rapidly, and cast as quickly as possible, to prevent the oxidation of this metal. The principles explained, relative to the casting of bronze in the small way, may, in general, be applied to the same operation in the large; nevertheless, some particulars necessarily require fresh instructions.

The founder in bronze must endeavour to obtain a quick fusion, in order to avoid those causes of loss above indicated. The form of the furnace, the nature of the combustible, and the mode of operating, comprise all the conditions necessary to succeed.

Reverberatory furnaces have been long adopted for this operation: of these, we prefer those of an elliptical form. Furnaces with spherical arches are employed by bell-founders; because their alloy being more fusible, they do not require a very elevated temperature; nevertheless, as the rapidity of the operation is always essential, it would be to their advantage to use elliptical furnaces.

Wood was formerly the only fuel employed; but pit-coal has, of late years, been substituted with very great advantage.

The mode of operating in the large way, depends upon the metals which enter into the composition of the bronze: but we must always particularly guard against oxidation. The first means consists in the rapidity of the fusion: sometimes we throw on the surface of the fusing metals, some charcoal, broken into small pieces (but not so small as to hazard any chance of their being carried away by the current of the flame), and often mix it with their scoriæ. It

is also highly essential, if we would add zinc in any great proportion, to slip this metal (made into thin plates) under the layer of burning charcoal: the charcoal must then be removed, without mixing it with the metal, which must then be well stirred together, and cast as quickly as possible: the same precautions are necessary when tin is added. In general, the metals which are the most alterable by the fire, should be the last added, in order that they may be the less time exposed to its action. The metal must also be stirred very briskly, in order to effect their combination, which is often difficult, on account of their great difference in density. This difference produces a divellent force, which is opposed to their affinity; and is so considerable, that even in the moulds it acts on the liquid bronze, and is one of the causes of the necessity of cooling it as quickly as possible. We profit, under some circumstances, by this force, derived from their different specific gravities, in order to separate certain metals from others; as in the process of *liquation*, &c.

The alloying of a small quantity of iron with bronze is sometimes useful, as we have above stated; but it is very difficult to unite it in a direct manner: on the contrary, it alloys without any trouble, if it be previously tinned; and thus it is in the state of tinned iron that it must be added to the bronze. This alloy is, however, very apt to alter in the casting; the iron separating from it, and passing into the form of oxide in the scoriæ.

Arsenic is directly alloyed with bronze, for the *speculums* of *telescopes*: (this is an alloy of copper, tin, platina, and arsenic). It is essential to guard this mixture against oxidation whilst casting; which is done by means of a flux of powdered glass, which forms a layer impermeable to the air, so that the entire surface of the metallic mixture is secured from its action.

As for those alloys of bronze into whose composition gold or silver enter, it is of little importance to know the manner

of forming them, as they are not employed in the Arts*. We have thus treated on the various compositions of bronze, and on a variety of its applications: we shall now explain the means by which we can extract from the bronze its constituent metals; and particularly the copper and tin, which are generally found in it in the greatest quantities. This process, which was used during and since the Revolution, is due to Fourcroy. At that period, a very considerable quantity of scoriæ were produced; which, from not being able to treat usefully, were thrown on the roads, to mend them; and at Romilly, near Rouen, they had been thrown up as a bank. When MM. Anfrye and Lecour were employed to reduce these scoriæ, they succeeded so well, that they formed an establishment to effect this extraction in the large way; and, in a few years, they brought into the market very considerable quantities of copper and tin. They sent from their works, many hundred thousand kilogrammes of these two metals†.

Fourcroy's process is founded on the property which tin possesses, of being more fusible and oxidable than copper.

* We find, in commerce, many articles made of what is termed *White metal*; which is an alloy, without any fixed proportions, of copper, tin, lead, zinc, iron, &c. It is also called *Button metal*; and is obtained by fusing together various kinds of old waste pieces of copper, brass, &c.

† It appears, from a Report delivered to the Institute on this establishment, that very good tin was extracted by their processes: it contained, however, a little copper, like the English tin; but both these kinds of tin were more brittle and dull than the Malacca tin; which must be owing to the lead they contained. The Commissioners named to make this Report, MM. Vauquelin, Deyeux, Guyton, and Sage, found that the English tin, and that from the warehouses of MM. Anfrye and Lecour, contained,

Pure tin - - - - -	98.5
Lead, - - - - - -	1.0
Copper - - - - -	0.5
	100.

Malacca tin, the purest found in commerce, may be bent twenty times before it breaks; and shews, in breaking, great strength, and a particular grain: whilst the English tin, as well as that of MM. Anfrye and Lecour, broke at the third bending, and presented in the broken part a greyish grain. M. Bréant obtained, by a process to be presently described, a tin so pure, that it might be employed in tinning looking-glasses.

1. They begin by completely oxidizing a certain quantity of bell-metal, by calcining it in a reverberatory furnace: they then withdraw the oxide, and pulverize it.

2. They next put into the same furnace a fresh quantity of metal: they fuse it, and then add to it half its weight of the oxide from the former operation. They then raise the temperature, and stir the mixture carefully: after some hours, a quantity of copper, nearly pure, separates itself in the liquid form, and diffuses itself over the bed of the furnace; whilst the remainder is composed of the oxides of tin and copper, and a small quantity of the earthy substances from the furnace: the latter collect together on the surface of the fused metal, in the pasty form, called scoriæ, and are taken off by means of a rake or *rabble;* and, when the surface of the fused copper is uncovered, it is cast into ingots. The scoriæ are again pulverized; and they extract by levigation, or washing over, the metallic parts, such as the copper, &c., which were entangled in them. By this process, they extract from 100 kilogrammes of bell-metal about 50 kilogrammes of copper, which does not contain more than a hundredth part of foreign matters.

3. They mix the already-washed scoriæ with one-eighth part of their weight of pulverized charcoal; and then rub or grind the mixture carefully together, in order to operate upon it in the most intimate manner: it is then put into a reverberatory furnace, where, by the aid of a high temperature, they effect a second reduction, from which there results a fluid alloy, consisting of about 60 parts of copper and 40 of tin; the surface of the metal being again covered with a new scoriæ, containing a much greater proportion of tin than the first.

4. This alloy (of 60 parts of copper and 40 of tin) is calcined in the same reverberatory furnace, but without its being stirred: the air, acting on the surface of the fused metal, oxydizes the tin in a much greater proportion than the copper; the result of which is, that layers of oxide are formed, having a certain degree of consistency,

which are removed from time to time. This operation is continued until the metallic alloy which remains becomes bell-metal: it is then cast into ingots, to be submitted to the same processes as the bell-metal we have before mentioned, in process No. 1.

The layers of oxide, successively removed during this operation, are united, mixed with charcoal, and reduced in a furnace proper for the reduction of tin.

5. By a similar process, and in a similar furnace, are reduced all the scoriæ rich in tin, produced from those which have been treated with charcoal in the reverberatory furnace (No. 3): from this is extracted an alloy, composed of 28 parts of copper and 72 of tin.

6. This last alloy is calcined in a reverberatory furnace, in the same manner as alloy No. 4, till the liquid metal consists of equal parts of copper and tin: until this time, it has only formed oxides of almost pure tin. The layers of oxided tin produced on the surface are successively removed, and the operation continued until the alloy, separated in the liquid form, is reduced to bell-metal; when it is cast into ingots, to be added to the others, and be treated as we have before mentioned respecting Nos. 1 and 5.

From the colour of the layers of oxide formed on the surface of the metal, they know when the period has arrived to remove them, and to stop the process. Whilst they are white, the layers only contain the oxide of tin nearly pure; but when they begin to turn grey, it is a certain sign that they contain the oxide of copper: finally, when the layers of oxide become of a very dark brown colour, they contain a large proportion of oxidated copper; and the fluid alloy which they cover is become bell-metal.

7. Lastly, they mix the oxide of tin with the tenth part of its weight of charcoal in powder: they grind this mixture up with water, and treat it in the reducing furnace for tin. The oxide of tin is thus reduced to the metallic state, and is generally obtained sufficiently pure. If, neverthe-

less, it should happen to contain too much copper, it is sufficient to melt it in a cast-iron pot, and let it cool slowly, to that point of temperature which is not sufficiently elevated to char paper: the copper is precipitated at this moment to the bottom of the vessel (alloyed with a certain quantity of tin), in the form of a pasty mass: the uppermost layers of metal contain only tin: these are removed with precaution, layer by layer, and cast into separate ingots.

(To be completed in our next Number.)

XXXI.—*On the Fusion of Plumbago, or Graphite, (commonly called Black-Lead,) into Substances greatly resembling Diamonds. By Professor* BENJAMIN SILLIMAN. —*From his Letter to Professor* ROBERT HARE, *M.D.**

MY DEAR SIR, *Yale College, Connecticut, March* 26, 1823.

In a former Letter, I gave an account of the fusion and volatilization of charcoal, by the use of your Galvanic deflagrator. I have now to add, that the fusion of plumbago was accomplished yesterday by the same instrument; and that I have again obtained the same results to-day. For this purpose, from a piece of very fine and beautiful plumbago from North Carolina, I sawed small parallelopipeds, about one eighth of an inch in diameter, and from three-fourths of an inch to an inch and a quarter in length: these were sharpened at one end; and one of them was employed to point one pole of the deflagrator, while the other was terminated by prepared charcoal. Plumbago being, in its natural state, a conductor, (although inferior to prepared charcoal,) a spark was readily obtained, but, in no instance, of half the energy which belongs to the instrument when in full activity; for the zinc coils were very much corroded, and some of them had failed and dropped out: still, the influence was readily conveyed, through the remaining coils. As my hopes of success, in the actual state of the instrument, were not very sanguine,

* From Vol. VI. No. 2. of the *American Journal of Science and Art.*

I was the more gratified to find a decided result in the very first trial. To avoid repetitions, I will generalize the results. The best were obtained when the plumbago was connected with the copper, and prepared charcoal with the zinc pole. The spark was vivid; and globules of melted plumbago could be discerned, even in the midst of the ignition, *forming* and *formed* upon the edges of the focus of heat. In this region, also, there was a bright scintillation, evidently owing to combustion; which went on where air had free access, but was prevented by the vapour of carbon, which occupied the highly luminous region of the focus between the poles, and of the direct route between them. Just on, and beyond, the confines of the ignited portion of the plumbago, there was formed a belt of a reddish-brown colour, a quarter of an inch or more in diameter; which appeared to be owing to the iron, remaining from the combustion of the carbon of that part of the piece; and which, being now oxided to a maximum, assumed the usual colour of the peroxide of that metal.

In various trials, the globules were formed very abundantly on the edge of the focus; and, in several instances, were studded around so thickly, as to resemble a string of beads; of which the largest were of the size of the smallest spot; others were merely visible to the naked eye; and others still were microscopic. No globule ever appeared on the point of the plumbago, which had been in the focus of heat; but this point presented a hemispherical excavation; and the plumbago there had the appearance of black scoriæ, or volcanic cinders. These were the general appearances at the copper pole, occupied by the plumbago.

On the zinc pole, occupied by the prepared charcoal, there were very peculiar results. This pole was, in every instance, elongated towards the copper pole; and the black matter accumulated there presented every appearance of fusion, not into globules, but into a fibrous and striated form, like the half-flowing slag found on the upper currents of lava. It was evidently transferred, in the state of

vapour, from the plumbago of the other pole; and had been formed by the carbon taken from the hemispherical cavity. It was so different from the melted charcoal, described in my former communications, that its origin from the plumbago could admit of no reasonable doubt. I am now to state other appearances, which have excited in my mind a very deep interest. On the end of the prepared charcoal, and occupying, frequently, an area of a quarter of an inch or more in diameter, were found numerous globules of perfectly-melted matter, entirely spherical in their form, having a high vitreous lustre, and a great degree of beauty. Some of them, and generally they were those most remote from the focus, were of a jet black, like the most perfect obsidian; others were brown, yellow, and topaz-coloured; others, still, were greyish white, like pearl-stones, with the translucence and lustre of porcelain; and others, still, limpid, like flint glass, or, in some cases, like hyalite or precious opal, but without the iridescence of the latter. Few of the globules upon the zinc pole were perfectly black, while very few of those on the copper pole were otherwise. In one instance, when I used some of the very pure English plumbago (sawn from a cabinet specimen, and believed to be from Borrowdale), white and transparent globules were formed on the copper side.

When the points were held *vertically, and the plumbago uppermost,* no globules were formed on the latter; and they were formed on the latter; and they were unusually numerous, and almost all black, on the opposite pole. When the points were exchanged, plumbago being on the zinc, and charcoal on the copper end, very few globules were formed on the plumbago, and not one on the charcoal: this last was rapidly hollowed out into a hemispherical cavity, while the plumbago was as rapidly elongated by matter accumulating at its point, and which, when examined by the microscope, proved to be a concretion, in the shape of a cauliflower, of volatilized and melted charcoal, having, in a high degree, all the characteristics which I formerly de-

scribed as appertaining to this substance. Indeed, I found, by repetitions of the experiment, that this was the best mode of obtaining fine pieces of melted charcoal.

In some instances, I used points of plumbago on both poles, and always obtained melted globules on both: the results were, however, not so distinct as when plumbago was on the copper, and charcoal on the zinc pole; but the same elongation of the zinc and hollowing of the copper pole took place as before. *I detached some of the globules, and, partly bedding them in a handle of wood, tried their hardness and firmness: they bore strong pressure without breaking; and easily scratched, not only flint-glass, but window-glass, and even the hard green variety which forms the aqua-fortis bottles. The globules which had acquired this extraordinary hardness* were formed from plumbago, which was so soft, that it was perfectly free from resistance when crushed between the thumb and finger, and covered their surfaces with a shining metallic coat. These globules sunk very rapidly in strong sulphuric acid, much more so than the melted charcoal, but not with much more rapidity than the plumbago itself, from which they had been formed.

The zinc of the deflagrator is now too far gone to enable me to prosecute this research any farther at present. As soon as the zinc-coils can be renewed, I shall hope to resume it; and I entertain strong hopes, especially from the new improved and much enlarged deflagrator which you are so kind as to lead me soon to expect from Philadelphia.

April 12.—Having refitted the deflagrator with new zinc-coils, I have repeated the experiments related above; and have the satisfaction of stating, that the results are fully confirmed, and even, in some respects, extended. The deflagrator now acts with great energy; and, in consequence, I have been enabled to obtain good results when using plumbago upon *both* poles. Parallelopipeds of that substance, one fifth of an inch in diameter, and one or two inches long, being screwed into the vices connecting the poles, on being brought into contact, transmitted the fluid

with intense splendour, and became fully ignited for an inch on each side: on being withdrawn a little, the usual arch of flame was formed, for half an inch or more. Indeed, when the instrument is in an active state, the light emitted from the plumbago points appears to be even more intense and rich than from charcoal; so that they may be used with advantage, in class experiments, where the principal object is to exhibit the brilliancy of the light.

On examining the pieces, in this, and in numerous other cases, I found them beautifully studded with numerous globules of melted plumbago. They extended from within a quarter of an inch of the point, to the distance of one quarter or one-third of an inch all around. *They were larger than before, and perfectly visible to the naked eye:* they exhibited all the colours before described, from perfect black to pure white, including brown, amber, and topaz colours. *Among the white globules, some were perfectly limpid, and could not be distinguished, by the eye, from portions of diamond.* In different repetitions of the experiment with the plumbago points, there were some varieties in the results. In one instance only was there a globule formed on the point: it would seem as if the melted spheres of plumbago, as soon as formed, rolled out of the current of flame, and congealed on the contiguous parts. In every instance, the plumbago on the copper side was hollowed out, into a spherical cavity; and the corresponding piece on the zinc side received an accumulation more or less considerable. In most instances, and in all when the deflagrator was very active, besides the globules of melted matter, a distinct tuft or projection was formed on the zinc pole, considerably resembling the melted charcoal described in my former communications, but apparently denser and more compact: although resembling the melted charcoal, as one variety of volcanic slag resembles another, it could be easily distinguished, by an eye familiarized to the appearances. In one experiment, the cavity, and all the parts of the plumbago at the copper pole, were completely melted on

the surface, and covered with a black enamel. The appearances were somewhat varied, when specimens of plumbago from different localities were used. In some instances, it burnt, and even deflagrated, being completely dissipated in brilliant scintillations: the substance was rapidly consumed, and no fusion was obtained. This kind of effect occurred most distinctly, when there was a plumbago piece on the copper side, and a piece of charcoal on the zinc side. I have already mentioned the curious result which is obtained when this arrangement is reversed,—the charcoal on the copper, and the plumbago on the zinc side: this effect was now particularly distinct and remarkable; the charcoal on the copper side was rapidly volatilized, a deep cavity was formed, and the charcoal taken from it was instantly accumulated upon the plumbago point, forming a most beautiful protuberance, completely distinguishable from the plumbago, and presenting, when viewed by the microscope, a congeries of aggregated spheres, with every mark of perfect fusion, and with a perfectly metallic lustre. I would again recommend this arrangement, when the object is to obtain fine pieces of melted charcoal.

April 14.—In repeating the experiment to-day, I have obtained even finer results than before. The spheres of melted plumbago were, in some instances, so thickly arranged, as to resemble shot lying side by side: in one case they completely covered the plumbago, in the part contiguous to the point on the zinc side; and were, without exception, white, like minute delicate concretions of mammillary chalcedony: among a great number, there was not one of a dark colour; except, that when detached by the knife, they exhibited slight shades of brown, at the place where they were united with the general mass of plumbago. They appeared to me to be formed by the condensation of a white vapour, which, in all the experiments where an active power was employed, I had observed to be exhaled from between the poles; and partly to pass from

the copper to the zinc pole, and partly to rise vertically, in an abundant fume, like that of the oxide proceeding from the combustion of various metals. I mentioned this circumstance in the report of my first experiments; but did not then make any trial, to ascertain the nature of the substance. Although its abundance rendered the idea improbable, I thought it possible that it might contain alkali, derived from the charcoal. It is easily condensed by inverting a glass over the fume as it rises, when it soon renders the glass opaque, with a white lining. Although there was a distinct and peculiar odour in the fume, I found that the condensed matter was tasteless, and that it did not effervesce with acids, or affect the test colours for alkalies. Besides, as it is produced apparently in greater quantities when both poles are terminated by plumbago, it seems possible that it is white volatilized carbon, giving origin, by its condensation, in a state of greater or lesser purity, to the grey, white, and perhaps to the limpid globules.

The deflagrator having been refitted only at the moment when a part of this Paper had already gone to the press, and the remainder is called for, I was precluded, by these circumstances, from trying the decisive experiment, of heating this white matter, by means of the solar focus, in a jar of pure oxygen gas, to ascertain whether it will produce carbonic acid gas.

This trial I have this morning made, upon the coloured globules obtained in the former experiments: they were easily detached from the plumbago, by the slightest touch from the point of a knife; and when collected in a white porcelain dish, they rolled about like shot, when the vessel was turned one way and another. To detach any portions of unmelted plumbago which might adhere to them, I carefully rubbed them between my thumb and finger, in the palm of my hand. I then placed them upon a fragment of Wedgewood-ware floated in a dish of mercury, and slid over them a small jar of very pure oxygen gas, whose entire freedom from carbonic acid had been fully secured by

washing it with solution of caustic soda; and, by subsequently testing it with recently-prepared lime-water. The globules were now exposed to the solar focus from a lens, it was near noon, and the sky but very slightly dimmed by vapour. Although they were in the focus for nearly half an hour, they did not melt, disappear, or alter their form; it appeared however, on examining the gas, that they had given up part of their substance to the oxygen; for carbonic acid was formed, which gave a decided precipitate with lime-water. Indeed, when we consider that these globules had been formed in a heat vastly more intense than that of the solar focus, we could not reasonably expect to melt them in this manner; and they are of a character so highly vitreous, that they must necessarily waste away very slowly, even when assailed by oxygen gas. In a long-continued experiment, it is presumable that they would be eventually dissipated, having only a residuum of iron. That they contain iron, is manifest, from their being attracted by the magnet; and their colour is evidently owing to this metal. Plumbago, in its natural state, is not magnetic; but it readily becomes so, by being strongly heated, although without fusion; and even the powder obtained from a black-lead crucible, after enduring a strong furnace heat, is magnetic. It would be interesting to know whether the limpid globules are also magnetic; but this trial I have not yet made.

I have already stated, that the white fume, mentioned above, appears when points of charcoal are used. I have found that this matter collects, in considerable quantities, a little out of the focus of heat around the zinc pole; and occasionally exhibits the appearance of a frit of white enamel, or looks a little like pumice-stone; only it has the whiteness of porcelain, graduating, however, into light grey, and other shades, as it recedes from the intense heat. In a few instances, I obtained upon the charcoal, when this substance terminated *both* poles, distinct limpid spheres; and at other times they adhered to the frit, like

beads on a string. Had we not been encouraged by the remarkable facts already stated, it would appear very extravagant to ask, Whether this white frit, and these limpid spheres, could arise from carbon volatilized in a white state, even from charcoal itself, and condensed in a form analogous to the diamond? The rigorous and obvious experiments necessary to determine this question, it is not now practicable for me to make; and I must, in the mean time, admit the *possibility*, that alkaline and earthy impurities may have contributed to the result.

In one instance, contiguous to, but a little aside from the charcoal points, I obtained isolated dark-coloured globules of melted charcoal, analogous to those of plumbago.

The opinion which I formerly stated, as to the passage of a current from the copper to the zinc pole of the deflagrator, is, in my view, fully confirmed. Indeed, with the protection of green glasses, my eyes are sufficiently strong to enable me to look steadily at the flame during the whole of an experiment; and I can distinctly observe matter in different forms, passing to the zinc pole, and collecting there, just as we see dust or other small bodies driven along by a common wind: there is also an obvious tremor produced on the copper pole, when the instrument is in vigorous action; and we can perceive an evident vibration produced, as if by the impulse of an elastic fluid, striking against the opposite pole.

If, however, the opinion which you formerly suggested to me, and which is countenanced by many facts, that the poles of the deflagrator are reversed,—the copper being positive, and the zinc negative,—be correct, the phænomena, as it regards the course of the current, will accord perfectly well with the received electrical hypothesis.

The number of unmelted substances being now reduced to two, namely, the anthracite and the diamond, you will readily suppose I did not neglect to make trial of them. As, however, the diamond is an absolute non-conductor, and the anthracite very little better, I cannot say I had

any serious hopes of success. I have made various attempts, which have failed: and, after losing two diamonds, the fragments being thrown about with a strong decrepitation, I have desisted from the attempt; having, as I conceive, a more feasible project in view.

I trust you will not consider the details of the preceding pages as being too minute, provided the subject appears to you as interesting as it does to me. The fusion of charcoal and of plumbago is sufficiently remarkable; but the evident approximation of the material of these bodies towards the condition of diamond, from which they differ so remarkably in their physical properties, affords, if I mistake not, a striking confirmation of some of our leading chemical doctrines.

I remain, as ever, your faithful friend and servant,

B. SILLIMAN.

XXXII.—*Experiments upon Diamond, Anthracite, and Plumbago, with the Compound Blow-pipe. From a Letter addressed to Professor* ROBERT HARE, *M.D. by Professor* BENJAMIN SILLIMAN.*

MY DEAR SIR, *Yale College, Connecticut, April* 15, 1829.

HAVING, last year, caused to be constructed an apparatus capable of containing fifty-two gallons of gas for the supply of your compound or oxy-hydrogen blow-pipe, and capable of receiving a strong impulse from pressure, I have been intending, as soon as practicable, to subject the diamond, and the anthracite, to its intense heat. Although their being non-conductors would be no impediment to the action of the blow-pipe flame upon them; still, obvious considerations have always made me consider the success of such experiments as very doubtful. I allude, of course, to the combustibility of these bodies; from which we might expect that they would be dissipated by a flame sustained by oxygen gas.

* From Vol. VI. No. 2, of the *American Journal of Science and Art.*

My first trials were made by placing small diamonds in a cavity in charcoal; but the support was, in every instance, so rapidly consumed, that the diamonds were speedily displaced by the current of gas. I next made a chink in a piece of solid quick-lime, and thrust the diamond into it: this proved a very good support; but the effulgence of light was so dazzling, that, although through green glasses I could steadily inspect the focus, it was impossible to distinguish the diamond, in the perfect solar brightness. This mode of conducting the experiment proved, however, perfectly manageable; and a large dish, placed beneath, secured the diamond from being lost, (an accident which I had more than once met with,) when suddenly displaced by the current of gas. As, however, the support was not combustible, it remained permanent; except that it was melted in the whole region of the flame, and covered with a perfectly white enamel, of vitreous lime. The experiments were frequently suspended, to examine the effect on the diamonds. They were found to be rapidly consumed; wasting so fast, that it was necessary, in order to examine them, to remove them from the heat at very short intervals: they exhibited, however, marks of *incipient fusion*. My experiments were performed upon small wrought diamonds, on which there were numerous polished facets, presenting extremely sharp and well-defined solid edges and angles. These edges and angles were always rounded, and generally obliterated. The whole surface of the diamond lost its continuity, and its lustre was much impaired: it exhibited innumerable very minute indentations, and intermediate and corresponding salient points; the whole presenting the appearance of having been superficially softened, and indented by the current of gas, or perhaps of having had its surface unequally removed by the combustion. In various places, near the edges, the diamond was consumed, with deep indentations; and occasionally, where a fragment had snapped off by decrepitation, it disclosed a conchoidal

fracture, and a vitreous lustre. These results were nearly uniform, in various trials: and every thing seems to indicate, that, were the diamond a good conductor, it would be melted by the deflagrator; and were it incombustible, a globule would be obtained by the compound blow-pipe.

In one experiment, in which I used a support of plumbago, there were some interesting varieties in the phænomena. The plumbago being a conductor, the light did not accumulate as it did when the support was lime, but permitted me distinctly to see the diamond through the whole experiment. It was consumed with great rapidity; a delicate halo of bluish light, clearly distinguishable from the blow-pipe flame, hovered over it; the surface appeared as if softened; numerous distinct but very minute scintillations were darted from it in every direction; and I could see the minute cavities and projections, which I have mentioned, forming every instant. In this experiment, I gave the diamond but one heat, of about a minute; but, on examining it with a magnifier, I was surprised to find that only a very thin layer of the gem, not much thicker than writing paper, remained, the rest having been burnt.*

I subjected the anthracite of Wilkesbarre, Pennsylvania, to similar trials; and, by heating it very gradually, its decrepitation was obviated. It was consumed with almost as much rapidity as the diamond; but exhibited, during the action of the heat, an evident appearance of being superficially softened. I could also distinctly see, in the midst of the intense glare of light, very minute globules forming upon the surface. These, when examined by a magnifier, proved to be perfectly white and limpid; and

* In Tillooh's Phil. Mag. for November 1821, Vol. 58, page 386, I observe the following notice, by Mr. John Murray.

"By repeatedly exposing a diamond to the action of the oxy-hydrogen blow-pipe in a nidus of *magnesia*, it became as *black* as charcoal, and split into fragments which displayed the *conchoidal* fracture.

"It will be found, that this gem, affixed in magnesia, soon flies off in minute fragments, exhibiting the impress of the conchoidal form.

"In lately exposing the diamond, fixed on a support of pipe-clay, to the ignited gas, I succeeded in completely *indenting* it:—examined after the experiments, it exhibited proofs of having undergone *fusion*."

the whole surface of the anthracite exhibited, like the diamond, only with more distinctness, cavities and projections, united by flowing lines, and covered with a black varnish, exactly like some of the volcanic slags and semi-vitrifications. The remark already made, respecting the diamond, appears to be equally applicable to the anthracite; *i. e.* that its want of conducting power is the reason why it is not melted by the deflagrator, and its combustibility is the sole obstacle to its *complete* fusion by the compound blow-pipe.

I next subjected a parallelopiped of plumbago to the compound flame. It was consumed with considerable rapidity, but presented, at the same time, numerous globules of melted matter, clearly distinguishable by the naked eye; and, when the piece was afterwards examined with a good glass, it was found richly adorned with numerous perfectly white and transparent spheres, connected also by white lines of the same matter, covering the greater part of the surface, for the space of half an inch at and around the point, and presenting a beautiful contrast with the plumbago beneath, like that of a white enamel upon a black ground.

In subsequent trials, upon pieces from various localities, foreign and domestic, (confined however to very pure specimens,) I obtained still more decided results: the white transparent globules became very numerous, and as large as small shot; they scratched window glass—were tasteless—harsh, when crushed between the teeth—and they were not magnetic. They very much resembled melted silex; and might be supposed to be derived from impurities in the plumbago, had not their appearance been uniform in the different varieties of that substance, whose analysis has never, I believe, presented any *combined* silex; and neither good magnifiers, nor friction of the powder between the fingers, could discover the slightest trace of any foreign substance in these specimens. Add to this, in different

experiments, I obtained very numerous perfectly black globules on the same pieces which afforded the white ones. In one instance, they covered an inch in length, all around: many of them were as large as common shot; and they had all the lustre and brilliancy of the most perfect black enamel. Among them were observed, here and there, globules of the lighter-coloured varieties. In one instance, the entire end of the parallelopiped of plumbago was occupied by a single black globule. The dark ones were uniformly attracted by the magnet; and, I think, were rather more sensible to it than the plumbago; which had been ignited, but not melted. We know how easily, in substances containing iron, the magnetic susceptibility is changed by slight variations of temperature. I am aware, however, that the dark globules may contain more iron than the plumbago from whence they were derived; as the combustion of part of the carbon may have somewhat diminished the proportion of that substance. I find that the fusion of the plumbago, by the compound blow-pipe, is by no means difficult; and the instrument being in good order, good results may be anticipated with certainty. As the press is waiting while I write, it is not in my power to determine the nature of all these various-coloured globules; and particularly, to ascertain whether the abundant white globules are owing to earths combined with the plumbago, or whether they are a different form of carbon. If the former be true, it proves that no existing analysis of plumbago can be correct; and would still leave the remarkable white fume, so abundantly exhaled between the poles of the deflagrator, and so rapidly transferred from the copper to the zinc pole, entirely unaccounted for. I would add, that, *for the mere fusion* of plumbago, the blow-pipe is much preferable to the deflagrator; but a variety of interesting phænomena, in relation to both plumbago and charcoal, are exhibited by the latter, and not by the former.

Hoping, that if these subjects have not already engaged your attention, they will speedily do so, I remain, my dear Sir, as ever,

Your friend and servant,

B. SILLIMAN.

Postscript, April 18.

FUSION OF ANTHRACITE.

The anthracite of Rhode Island is thought to be very pure. Dr. William Meade estimates its proportion of carbon at ninety-four per cent. This anthracite I have just succeeded in melting, by the compound blow-pipe. It gives large brilliant black globules, not attractable by the magnet, but in other respects not to be distinguished from the dark globules of melted plumbago. The experiment was entirely successful, in every trial: and the great number of the globules, and their evident flow from, and connexion with, the entire mass, permitted no doubt as to their being really the melted anthracite.

The Kilkenny coal gave only white and transparent globules: but it seems rather difficult to impute this to impurities, since this anthracite is stated to contain ninety-seven per cent. of carbon.

I have exposed a diamond, this afternoon, to the solar focus, in a jar of pure oxygen gas; but observed no signs of fusion, nor indeed did I expect it: but I wished to compare the old experiment with those related above.

The diamond is now the only substance which has not been perfectly melted.

I inserted a piece of plumbago into a cavity made in quick-lime, and succeeded in melting it down by the blow-pipe into two or three large globules, adhering into one mass, and occupying the cavity in the lime: these globules were limpid; and nothing remained of the original appearance of the plumbago, except a few black points.

XXXIII.—*On the Advantages attending the Employment of the Patent Metallic Pistons, and Metallic Substitutes for Stuffing-boxes, invented by Mr.* JOHN BARTON.

IN our last Number, we had occasion to notice various misrepresentations of Mr. Barton's Patent Improvements in Propelling, &c.; which, upon further examination, appear still worse than we at first conceived them to be; and, indeed, they evidently have tended to make his inventions appear totally useless. In the first place, the steam-boiler cannot be constructed as there shewn: and with respect to the pump and hydraulic engine, they are neither of them capable of raising water; for the moment the valve in the pump quits its seat, it stops the passage into the hollow pump-rod, or rising main, which is shewn in the misrepresented figure, as contracted, and placed just above the valve; whereas in the drawing of that figure in the specification, there is an abundant water-way provided. In the misrepresented figure of the hydraulic engine, the valves in the moving flaps would, of course, prevent any vacuum being formed; and, consequently, no water would rise into the engine.

Mr. Barton now represents to us other hardships to which he has been subjected, with respect to his Patent Metallic Pistons; and particularly, that in the United States of America, where they are extensively used, *they are not even known as his invention*, but as that of a Mr. Peter A. Browne, an American advocate; who came over to this country several years since, and persuaded Mr. Barton to allow him to take out a Patent there for their joint benefit; *but from which the latter has never yet enjoyed any advantage whatever.*

The following Letter to Dr. Samuel L. Mitchell, from Professor James Cutbush, of Philadelphia, dated January 11, 1817, (which appeared in the New-York Mercantile Advertiser on the 15th of that month,) sets forth the great advantages of these Metallic Pistons in a very clear light.

"Dear Sir,—Discoveries and improvements, whether in science, the Arts, or manufactures, made known to the public through a common channel, and sanctioned by men truly eminent, must necessarily call the attention of a discerning public, in order to appreciate their value and importance. The following account of a new application of the *wedge* and *spring* in mechanics, and the discovery of a mode of constructing pistons for all kinds of forcing and lifting-pumps, air-pumps, steam-engines, &c. without *packing*, as it is termed, which is the discovery of Peter A. Browne, esq. an eminent attorney at our bar, may be highly interesting to the artists of your city, and useful to the country at large. I speak of the *practical* utility of the discovery; by which, as the sure criterion of merit, as it respects utility, invention should be tested. Of this I am satisfied, having witnessed the operation of the piston, not only in the forcing-, but in the air-pump.

"When the workmanship is perfect in the cylinder and piston, it will always produce a vacuum.—This is evident, from the ebullition of ether, and other experiments in vacuo. Mr. ROSE, surgeon's-instrument maker, a workman of considerable merit, is now adapting this piston to the air-pump of the cupping instrument, which promises advantages decidedly in its favour. The model in the possession of Mr. Browne, the patentee, was made by Mr. Lukens, with his usual neatness and accuracy. I shall notice briefly its construction.

"The foot of the piston-rod gradually widens at the bottom, and fastens unto and fits in a flat circular plate, which constitutes the bottom of the piston. The rod is furnished with a screw and shoulder, a small distance from the bottom. There is an upper circular plate, of the same size as the under one, which rests upon this shoulder, and is confined in its place by a screwed nut. Between these plates are three segments or pieces of the same metal, which, when placed together, form a circle, the size of the cylinder; and between these are three triangular wedges, which act equally upon the segments of the circle. These

wedges rest against a metallic spring, which is circular in form, and of sufficient power and elasticity. The spring, by its expansion, forces the wedges forward; these again act on the three segments; so that a complete contact with the cylinder is produced.

"The piston, therefore, consists of the under and upper plates, the three segments, the three wedges, and the spring. It is obvious that the power of the spring is communicated or applied equally to the wedges, the spring being in contact with one of the sides of each; and that the wedges, in their turn, act equally, and uniformly, *as wedges*, on the three several segments. The segments then press against the cylinder in every point of contact, which, of course, must be against the whole cylinder; the diameter of the piston being the same as that of the cylinder.

"The wedges themselves are formed with great accuracy, and fit the segments, when the whole is arranged, with mathematical precision. In the operation of the piston, we may remark, that any space, however large or minute, which may arise from the enlargement of the circle by the pressure of the spring on the wedges, is filled, and the whole rendered air-tight. The segments, when put together, form an equilateral triangle in the centre; and the wedges which are inserted are also equilateral triangles.

"From the idea we have of this piston, we may readily perceive its superiority over the common kind; that the defects or imperfections to which those formed with PACKING are liable, are removed; and that its application may be general to any engine in which the piston is used, however large or small, and however simple or compound. Valves have been added by Mr. B. to answer the purpose of a lifting- and air-pump.

"I am so well satisfied, in opinion with other persons who have examined it, as to its utility, that, to do Mr. Browne justice, I consider that he has not only shewn considerable genius and talent, but has rendered an essential advantage by his invention, in discovering a permanent and effectual

substitute for the common packing and piston, or any appendage thereto.

"Mr. Rose will forward and present to you an air-pump on this principle, in a few days.

"Very respectfully, Sir, your friend and obedient servant,

"JAMES CUTBUSH."

"SAMUEL L. MITCHELL, *M.D. Professor, &c.*"

We cannot sufficiently regret that any one should thus have deprived the inventor, *not only of all profit from his discovery, but also have laid claim to the invention itself.* We also find, that the invention is known in France, by the name only of "Browne's Metallic Pistons."

We are also sorry to learn from him, that several persons are now pirating his invention in this country, and enjoying the benefit of his improvements, without making the least acknowledgment in return.

Others, however, have been more liberal to him; and have not only satisfied him in a pecuniary way, but have likewise furnished him with testimonials, in writing, of their approbation of his inventions. We are particularly glad to find, amongst the testimonials, the two following, from Mr. Perkins.

"This may certify, that I have had Barton's Flexible Metallic Piston some months in use; and that I consider it the best and most perfect of any which has come to my knowledge, either for steam-engines, or other purposes.

"*London, June 4th,* 1823." "J. PERKINS."

"Mr. JOHN BARTON—

"SIR, I have used your Patent Piston and Stuffing-box above three months, in my engine. The friction is much less than any I have yet tried. I have had the steam *up to* 1400 *lbs. to the inch, without any leakage to signify.* I generally work with steam from 400 to 500 lbs. to the inch, and find them quite tight enough for all practical purposes. The wear appears to be not the least objection to them.

"I am, Sir, your obedient servant,

"41, *Water Lane, July* 24, 1823." "JACOB PERKINS."

In addition to these Certificates, we are glad to give our own testimony of their excellence, having just had an opportunity of witnessing the effect of the three months' wear upon the piston; and which was, to polish it highly, and to fit it most accurately to the cylinder; in short, to make it perfect.

The action of the metallic substitute for a stuffing-box upon the piston-rod was also equally satisfactory.

Both the piston and stuffing-box were made of hardened and tempered steel; and had been heated by the high-pressure steam to that degree, that it was feared the springs would have suffered thereby: luckily, however, no mischief has happened to them.

Mr. Barton has also laid before us, the following Certificate from Messrs. Howard, of Rotherhithe; who have both pistons and stuffing-boxes of his improved construction, in their steam-engines of 14 and 40-horses' power.

"Mr. JOHN BARTON, "*Iron Mills, Rotherhithe, Aug.* 16, 1823.

"In reply to your request, of being informed how far we are satisfied with the two metal pistons you put to our steam-engines; we think it a clever invention, and that it may be adopted in most cases to advantage, as is the case with ours. Though, with the old one, you had not a reasonable prospect of making a perfect job at first, the cylinder is wearing very smooth; and we consider a few months more work will bring it to as nice a bearing as could be looked for. With new, perfect cylinders, you would, of course, have much better chance.

"I am, for Thomas Howard, Self, and Co.

"Yours respectfully,

"WM. HOWARD."

The following, from Mr. George Ledger, Calenderer and Presser, is particularly satisfactory, as evidencing the great length of time these pistons will wear, without even requiring to be attended to.

Mr. BARTON, "*Maze Pond, Southwark, Aug.* 14, 1823.

"SIR, I have had your patent piston and air-pump bucket at work upwards of four years, in my steam-engine: *they worked two years, and upwards, without requiring to be looked at; and were perfectly tight.* We since examined them: they are in the most perfect condition: and I expect, from their appearance, they will last twenty years.

"GEORGE LEDGER."

It would be endless to copy all the certificates now lying before us: we shall therefore content ourselves with giving extracts from the more important ones. Messrs. Thornhill and Morley, Cutlers, in New Bond-street, stated, in the year 1819, that they were able then to work their engine with perfect safety;—that before the application of Mr. Barton's patent piston, they required steam of a pressure of 7*3lbs.* on the inch; but, with it, they do more work at 4*3lbs.* only;—and, that, for three years, they had not had a single stoppage, as it continued perfectly tight. Mr. George Smart, late of the Steam Mills at the Ordnance Wharf, Westminster-Bridge, states, in 1818, that he has had Mr. Barton's *air-pump bucket at work, day and night, for upwards of eighteen months*;—that, when it was first put in, *the pump-barrel was worn very bad with the sharp sand of the Thames*;—the packing used before, with the common bucket, seldom lasted above a month; as their water was drawn a great way at low tide, and they suffered much in consequence, from its quantity being deficient for condensation; an evil which the new bucket corrected;—that, on looking at the bucket a few weeks since, they were agreeably surprised at finding it but little worn; and the working-piece so much improved, that they had every appearance of lasting twenty years;—that the piston and stuffing-box put into their condensing-engine were invaluable, as they never had a stoppage with either of them;—that they were satisfied the engines would do more work with the patent improvements than before, and would last much longer;

as the friction was nearly all removed, and they even became tighter by use. Several certificates, from Engineers to Cornish mines, speak highly favourably of the great advantages of these patent pistons. The Engineers of the London and Richmond steam-packets, in the year 1819, say, that before the adoption of the patent metallic pistons, they were unable to keep up the steam, even with an expenditure of six sacks of coals per day; but that, for the three months since the patent pistons had been applied, they could keep up the steam with ease, with four sacks only, being one-third less than before; and with only one-half the quantity of tallow formerly used;—and, also, that the speed of the packets was greatly increased. Messrs. T. V. Cooke and Co., eminent malt-distillers, Thames Bank, have had the patent metallic piston in use ever since the year 1818, and a metallic air-pump bucket since the year 1820; both of which have given the greatest satisfaction. Mr. John Garford, of the Steam Oil Mills, Limehouse, has furnished two certificates; viz. one in the year 1820, and another in 1821. In the first of these, he says, that he approves of the metal bucket, 8 inches in diameter, supplied by Mr. Barton for the cold-liquor pump of his 20-horse steam-engine (made by Messrs. Boulton and Watt), and that it had been in use 14 hours per day, near four months, perfectly to his satisfaction. The former bucket was geared with leather, which seldom lasted twenty days, and frequently caused much loss of time to his workmen, whilst refitting it. The pump being exposed to draw small gravel, had much gulled the barrel. When the new bucket was put in, the barrel was bored as close as the substance of it would permit, but not enough to take out all the furrows; and that, on examining the bucket twice, he found that it had fitted itself to the indents.—His certificate in the year 1821 is equally favourable. In a certificate from Mr. Henry Peto, of Little Britain, in the year 1819, he says, he feels it a duty to inform Mr. Barton, that he considers the hydraulic engine, put up at the late Aldgate Gas-works, with

his patent metallic piston and stuffing-box, as a most valuable improvement; as, after two years' daily work, it still continued to give the greatest satisfaction.* We shall finish our extracts, by adding, that Mr. William Bound, Iron-founder, Clerkenwell, states, in 1821, that the 16-inch patent metallic piston, put by Mr. Barton in his blast cylinder, had been in constant work nearly two years, without needing any repairs;—that it performed well; and he considered it to be a much better blast for a furnace, than when the piston was leathered in the old way.

We may add, that Mr. Barton supplied Messrs. Bramah, Engineers, of Pimlico, in the year 1818, with two of his patent metallic pistons, for a machine for the purpose of compressing hydrogen gas; which stood the pressure of upwards of twenty atmospheres, and gave perfect satisfaction.

Mr. Barton having favoured us with accurate working drawings of his patent metallic piston, as fitted up by him when employed in steam-engines where steam of an extraordinary degree of pressure is employed (such as those of Mr. Perkins's); and also of his metallic substitute for a stuffing-box; we hasten to lay them before our Readers.

In Plate VII. figs. 1 and 2, the piston is represented in two cross sections; the one vertical; and the other horizontal, through the dotted line AA, in fig. 1. In these figures, our Readers will find, that, although the principles of the metallic piston, as described in the American communication from Professor Cutbush, in the beginning of this Article, are preserved, yet that they are very considerably modified in the different parts; and that, instead of the piston consisting of the upper and under plates, the three segments, the three wedges, and the spring, as there described, it is here shewn as being composed of the solid cylindrical cast-iron body BB, having a conical hole, C, to

* Mr. Barton has since furnished Mr. Peto with another engine of a similar construction; by which the whole of New Furnival's Inn is supplied with water from a spring on the premises.

receive the enlarged end of the piston-rod D, upon which it is secured by a cross-pin, E, passing through both. A channel or groove, FF, is made around this body; in which are lodged the four cast-steel, hardened and tempered segments, GGGG; the four right-angled cast-steel wedges, HHHH, &c.; and the eight hardened and tempered steel heliacal springs, IIII, &c. which are lodged in cylindrical cavities, made both in the wedges and in the solid body of the piston, so as to allow them to play freely. In each spring, a steel cylindrical pin is also placed, a little shorter than the springs: the springs are thus prevented from bending out of the direct line of action. Three grooves are made around the exterior of the segments and wedges: the middle one is designed to hold oil, or grease, to lubricate the piston and cylinder: in the upper and lower grooves are lodged steel rings, hardened and tempered, and cleft across; these rings are made just to fill the grooves; and, when the piston is placed in the cylinder JJ, their ends meet. They are prevented from turning round in the grooves, by a small pin or stud in the middle of each, falling into a hole made in the groove, so as to keep the rings with their cleft ends in opposite directions to each other. The use of these rings is, chiefly, to prevent the moveable parts of the piston from falling asunder, and getting deranged, when the piston is taken out of the cylinder.

(To be continued.)

XXXIV.—*Queries on Preserving Fish. By a* CORRESPONDENT.

SIR, *Wolverhampton, Aug.* 19, 1823.

I TRUST you will not consider my application irrelevant to the objects of your valuable Repository.

Can you, from your own experience, or that of your Chemical associates, point out the best method of preserving Fish from speedy putrefaction; so that this delicious article of food may be safely forwarded from our distant shores, to the great encouragement of our fishermen, and

for the better supply of the metropolis, and the towns of the interior?

I more particularly allude to the Turbot and Cod Fisheries of the north-west coast of Ireland, and the coast of Wales, where these valuable fishes are in the greatest abundance; and which, in case of such an expedient, would become as great a national treasure as the Salmon Fishery on the coast of Scotland.

At present, these articles of food, comparatively speaking, are supplied in a very limited manner to the inhabitants of the interior, and often in such a state as to be unwholesome; while, if a suitable antiseptic could be employed for the preservation of the abundance taken on the more distant coasts, the advantages, in a private and *national* point of view, both to the fishermen and the public, would be incalculable; — more especially as the strong precautions taken to prevent smuggling, have, in a manner, neutralized both the means and exertions of the fishermen belonging to our nearest outports.

1. What the great advantages of destroying the life of fishes, on immediately taking them out of their element?

2. Would it be possible to preserve fish with sugar, as an antiseptic?

3. How would the pyroligneous acid answer, as an antiseptic? In what manner could it be most simply prepared? and how should it be used?

I am, Sir, Your obedient Servant,

To T. Gill, *Esq.* A Constant Reader.

XXXV.—LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal, since July 24, 1823.

To William Harwood Horrocks of Portwood, within Brinnington, in the county of Chester, Cotton Manufacturer; for a new and improved method, applicable to preparing, cleaning, dressing, and beaming Silk Warps; and

also applicable to beaming other Warps. Dated July 24, 1823.—To be specified in six months.

To Richard Gill, of Banydown, in the county of Rutland, Fellmonger and Parchment Manufacturer; for a new method of preparing, dressing, and dyeing Sheepskins and Lambskins with the Wool on, for Rugs, Carriages, Rooms, and other purposes. Dated July 24, 1823.—In two months.

To William Jeakes, of Great Russell Street, in the parish of St. George, Bloomsbury, in the county of Middlesex; for an Apparatus for regulating the Supply of Water in Steam Boilers, and other vessels for containing Water or other liquids. Dated July 24, 1823.—In six months.

To William Davis, of Bourne in the county of Gloucester, and of Leeds in the county of York, Engineer; for certain improvements in Machinery, for shearing and dressing Woollen and other Cloths, requiring such process. Dated July 24, 1823.—In six months.

To Henry Smart, of Berners Street, in the parish of St. Mary-le-bonne in the county of Middlesex, Piano-Forte Manufacturer; for certain improvements in the construction of Piano-Fortes. Dated July 24, 1823.—In six months.

To Miles Turner, and Lawrence Angell, both of Whitehaven, in the county of Cumberland, Soap-Boilers; for an improved process, to be used in bleaching of Linen or Cotton Yarn or Cloth. Dated July 24, 1823.—In two months.

To John Jackson, of the town of Nottingham, Gunmaker; for certain improvements in the construction of the Locks used for the discharge of Guns and other Fire-Arms, upon the detonating principle. Dated July 29, 1823.—In two months.

To Joseph Bower, of Hunslet, in the parish of Leeds, in the county of York, Oil-of-Vitriol Manufacturer; and John Bland, of Hunslet aforesaid, Steam-Engine Manu-

facturer; for a certain improvement in such Steam Engines as condense out of the Cylinder, by which improvement or invention the Air-pump is rendered unnecessary. Dated July 31, 1823.—In two months.

To John Bainbridge, of Bread Street, Cheapside, in the city of London, Merchant; who, in consequence of a communication received by him from a Foreigner resident in the United States of North America, is in possession of certain improvements upon Machines for cutting, cropping, or shearing Wool, or Fur, from Skins; also for cropping or shearing Woollen, Silk, Cotton, or other Cloths and Velvets, or any other Fabrick or Fabricks thereof respectively, whether made or composed entirely of Wool, Silk, Cotton, or other materials of which Cloth or Velvet is made; or of any Mixture or Mixtures thereof respectively; and also for the purpose of shaving Pelts or Skins. Dated July 31, 1823.—In six months.

To Louis John Pouchee, of King Street, Covent Garden, in the county of Middlesex, Type-Founder; who, in consequence of a communication made to him by a certain Foreigner residing abroad, is in possession of certain Machinery or Apparatus to be employed in the casting of Metal Types. Dated August 5, 1823.—In six months.

To Robert Dickinson, of Park Street, Southwark, in the county of Surrey, Esq.; for a certain improvement, in addition to the shoeing or stopping and treatment of Horses' Feet. Dated August 5, 1823.—In six months.

To James Barron, of Wells Street, in the parish of St. Mary-le-bonne, Venetian-Blind Manufacturer; and Jacob Wilson, of Welbeck Street, in the parish of St. Mary-le-bonne, Upholsterer; both in the county of Middlesex; for their improvements in the construction and manufacturing of Window Blinds. Dated August 11, 1823.—In six months.

To William Wigston, of Derby, in the county of Derby,

Engineer; for certain improvements on Steam Engines. Dated August 11, 1823.—In six months.

To Henry Constantine Jennings, of Devonshire Street, in the parish of St. Mary-le-bonne, in the county of Middlesex, Esq.; for his improvement or Machine for preventing the improper escape of Gas, and the danger and nuisance consequent thereon. Dated August 14, 1823.—In six months.

To John Malam, of Wakefield, in the county of York, Engineer; for a new mode of applying certain Materials, hitherto unused for that purpose, to the constructing of Retorts; and improvements in other parts of Gas Apparatus. Dated August 18, 1823.—In six months.

To Thomas Leach, late of Friday Street, in the city of London, Merchant, but now residing at Litchfield in the county of Stafford; for his improvements in certain parts of the Machinery for roving, spinning, and doubling Wool, Cotton, Silk, Flax, and all other fibrous substances. Dated August 18, 1823—In six months.

To Robert Higgin, of the city of Norwich, Shawl Manufacturer; for a new or improved method of consuming or destroying Smoke. Dated August 18, 1823.—In six months.

To George Diggles, of College Street, in the parish of St. John, Westminster, in the county of Middlesex, Gent.; for an improved Bit, for Riding Horses, and for Horses used in single and double harness. Dated August 19, 1823.—In six months.

To Robert Rogers, late of New Hampshire, in the United States of America; but now of Liverpool, in the county of Lancaster, Master Mariner and Ship Owner; for an improved Lanyard, for the Shrouds and other Rigging of Ships and other Vessels; and an Apparatus for setting up the same. Dated August 18, 1823.—In two months.

THE

TECHNICAL REPOSITORY.

XXXVI.—*On Curing British White Herrings with Mr.* PHILLIPS LONDON'S *British Solid Salt. By Mr.* JOHN LEWIS, *of Broadstairs, Kent. With additional information from Dutch Merchants, on the Cure of White Herrings.**

SIR, 8, *Lower Thames Street, Jan.* 28, 1813.

I BEG leave to inform the Society of Arts, &c. that I have this season cured six thousand five hundred and thirty-three barrels of white herrings, caught in the British Seas; a great part of which have been cured after the manner of the Dutch. The others were for the West-India, Baltic, Irish, and home markets.

The above is a much greater number of barrels than any other curer hath accomplished in the United Kingdom. I have sent to the Society a half barrel, as a specimen; and hope they will merit the Society's approbation. The Dutch commence their fishery in the deep sea, in the middle of the summer: the fishery at Broadstairs, where my herrings are cured, commences about the 10th of October. *My herrings are thoroughly impregnated with salt; for which purpose I prefer the patent English solid salt, which will preserve them good a long time, and even improve their flavour.* I am, very respectfully, Sir,

Your obedient servant,

To C. TAYLOR, *M.D. Sec.* JOHN LEWIS.

* From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society awarded its Premium of the Gold Medal to Mr. Lewis.

CERTIFICATE.

Broadstairs, Kent, Jan. 24, 1813.

This is to certify, that Mr. John Lewis has cured more than thirty barrels of *gypped* herrings, after the manner of the Dutch; and that the sample of half a barrel, sent to the Society by the sloop Speculation, is a fair sample of those cured by the said John Lewis.

JOHN KENNETT.
HENRY BANNER.
ROBERT BARFIELD.

Mr. LEWIS's *Process for Curing White Herrings.*

Broadstairs, Jan. 22, 1813.

The process used by me for curing white herrings, after the manner of the Dutch, is as follows:

As soon as possible after the herrings are caught, they are *gypped*, by cutting the blood veins of the neck across with a very small knife made for that purpose: the small guts are to be drawn out of this incision by the knife; and, at the same time, the neck-piece is to be cut out, right under the two fore fins. The herrings must then be thrown into a tub, and well roused (mixed up with salt); and packed immediately, whilst bleeding, into casks, laying a sufficient quantity of salt between each layer of herrings. Foreign salt has usually been employed for this purpose; but, from this year's experience, I find *the British solid salt equal, if not superior,* to any salt I have ever tried: and, agreeably to the Dutch system, the herrings must be laid well on their backs in the cask. The casks must be then headed up, and laid on their sides for a fortnight or three weeks; then be opened and filled up, and so put by, ready for shipping. This is the whole of the process.

I am, Gentlemen, your obedient very humble servant,

JOHN LEWIS.

To the Society of Arts, &c.

*** The Society, anxious to obtain every possible information upon the subject, procured the attendance of several

very respectable Dutch merchants, and other persons from Holland, well conversant in the business of taking and curing herrings, to investigate the herrings sent from Mr. Lewis, and to favour the Committee with further observations upon the subject. They commenced the business by a careful examination of the cask sent to the Society, smelling and tasting the pickle, and observing the manner in which the herrings were placed in the barrel. They then took out some of the herrings promiscuously from the cask; and shewed, from some *ungypped* herrings they brought with them, the manner of *gypping* the herrings, by making an incision, nearly in the form of a semicircle, under the neck, removing the gills and guts, in a similar manner to those cured by Mr. Lewis.

To prepare Mr. Lewis's herrings for eating, — They took them from the cask, without washing, and cut off a small slip, the whole length of the belly, as useless: an incision was then made the whole length, on the back of the fish, and the entire skin of the herring dexterously drawn off, commencing at the throat of the fish. The fish was then cut across obliquely, in the direction of the vertebræ, into pieces of three-fourths of an inch each, containing the bone in the centre of each; and thus laid on a plate, for the table, to eat with bread and butter. Some of them were prepared in another mode; namely, by holding the tail of the fish, when skinned as before described, between the finger and thumb of each hand; and, by dexterously turning it over the wrists, the herring was split the whole length, and separated from the bone, leaving the whole fleshy parts in two longitudinal pieces.

The Dutch gentlemen, after eating heartily of the herrings, concurred in the following sentiments:—

They declared Mr. Lewis's process of cure to be precisely the same as the Dutch method.

That the Dutch, in their cure, use generally the best Lisbon salt, well crystallized, in the proportion of one thousand pounds weight of salt to fourteen whole barrels

of herrings; each barrel containing from 1000 to 1200 herrings, according to their size.

That the Dutch commence their herring fishery on the 21st of June; and continue it, from 58 to 60 degrees north latitude, to the latter end of August; following the herrings, and continuing their fishery of them, southwards, from that time to the latter end of October.

That the Dutch always pack their herrings in oak casks; and for the West-India trade, pack them in small casks; as a cask of herrings will not keep good there, long after being opened.

That the signs of a good herring are, that the fat should run from the hands, in opening it; the flesh should appear clear and white; and the flavour be not too salt.

That the herrings caught in October, in latitude 40 degrees, are the best calculated for the West-India markets; having then shot their roes, and become meagre; and will, therefore, keep better.

That the Dutch herrings will keep good twelve months.

That Mr. Lewis's herrings are extremely good, and equal to the best Dutch, only rather too salt for home consumption.

They recommend, for the West-India trade, that Mr. Lewis's herrings should be repacked in smaller barrels, in the following manner:—The herrings should be laid upon their backs, very close to each other, the heads turned towards the outer circle of the cask; that when a layer is thus placed, and pressed hard, some salt should be taken up, between both hands open, and, by a sudden jerk, dispersed equally over the layer; the next layer of herrings should be laid directly cross-ways of the former, be pressed, and sprinkled with salt, as before; and the herrings be thus closely placed, salted, and packed, *stratum super stratum,* till the cask is well filled.

That the herrings are usually eaten, in Holland, as taken from the cask, without boiling, or any other culinary preparation; but that the roes are usually broiled before the fire, before they are eaten.

XXXVII. — *On Curing Herrings, Pilchards, Mackarel, Sprats, &c. by the use of the Patent British Solid Salt.* By *Mr.* PHILLIPS LONDON.*

WITH A FIGURE.

SIR, *No. 57, Cannon Street, April* 20, 1813.

I TAKE the liberty of sending to you, for the inspection of the Society of Arts, &c. what I think *a fine specimen of pickled mackarel, in their entire state.*

They were cured with *my British solid salt.* I am told, *the cure of mackarel, whole,* has hitherto been deemed almost impracticable.

I believe *split mackarel* have been salted and preserved, but in a very inferior state to these. If my mackarel should be thought deserving of future notice, I shall, with great pleasure, communicate with the Society upon the subject.

I am, Sir, your obedient servant,

PHILLIPS LONDON.

To C. TAYLOR, *M.D. Sec.*

CERTIFICATES.

British-Herring-Fishing Company's Office, London.

At a Meeting of the Directors, held at the Company's Office, March 23, 1813;—present,

KINNAIRD SMITH, *Esq. in the Chair;*
WILLIAM SMITH, *Esq. M.P.*
NATHANIEL BRICKWOOD, *Esq.*
JOHN CAPEL, *Esq.*
J. C. SAUNDERS, *Esq.*
THOMAS CRESSWELL, *Esq.*

RESOLVED, That the Secretary be directed to deliver to Mr. Phillips London, patentee of the British solid salt, a Certificate, as under:

Mr. London having this day produced to the Directors of the British-Herring-Fishing Company some mackarel cured with his patent solid salt; they do, in justice to Mr.

* From Vols. XXXI. XXXII. and XXXIII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted its Silver Medal, and also its Silver Medal set in Gold, to Mr. London, for these communications.

London, voluntarily certify and declare it to be their opinion, that *the mackarel so cured far surpassed in goodness any the Directors had before seen, both in point of colour and taste.*

The natural outside appearance of the mackarel was preserved nearly as bright as when they were fresh, although they had been in pickle since the last mackarel season: and when cut, were in high perfection; being of a reddish colour, very moist, and excellent in flavour.

A very small portion, likewise, of the salt in which it had been in pickle was dissolved; so that the whole which was left appeared fit for other uses.

The Directors feel pleasure in testifying these facts; which, if generally known, they hope may tend to the benefit of the community at large.

Signed, by order of the Board,

THOMAS SAUNDERS, Secretary.

To Mr. PHILLIPS LONDON.

SIR, *America Square, May* 4, 1813.

As some fishermen have been lately with me from Margate, on the business of a ship to which they lent assistance whilst on the Margate Sand, I conversed with them on the subject of the approaching mackarel fishery. They were astonished, when I told them that you had completely cured that fish with the *solid salt*; and their surprise was increased when I gave them a specimen of those which you caused to be cured in October last. They admired greatly the condition of the fish; and said, to use their own words, "that they had tried to cure them many a time and often, but never could succeed." They have taken the fish to Margate with great satisfaction; and think that the consequences will be very important, *as the take of mackarel on the British coast may be carried to an immense extent, and open a large foreign trade, as well as afford a wonderful supply for home consumption**.

* The probability of this event is now greatly increased, in consequence of the introduction among us of a lately-discovered American method of catching mackarel and other fish; for which Admiral Sir Isaac Coffin has recently obtained a Patent.—EDITOR.

I have also shewn the cured mackarel to one of the first Jamaica merchants; who adjudged it to be a new discovery; and said that the fish were perfectly cured, and fit for the West-India consumption.

The flavour of these cured mackarel appears to be as extraordinary as their preservation; being thought by some persons, for use as sandwiches and for the purposes of the table, equal, if not superior, to the anchovy.

I am, dear Sir, yours very respectfully,

R. T. MARTIN.

To Mr. PHILLIPS LONDON.

Mr. P. LONDON's *Process for Curing Mackarel.*

The salt which he uses for his pickle is *British salt refined by fusion*; in which operation, the impurities are separated by precipitation.

The strength of the brine, in which his fish are pickled, is, in specific gravity, in proportion to water, as 1205 to 1000.

He recommends the following plan for the cure:—

The fishing-boats to take out with them, vessels containing brine of the strength above mentioned; and the moment the mackarel are caught, they are to be put alive into this brine, without gutting, or any other preparation.

That, on barrelling them, a surplus of dry salt be added in the cask, to strengthen the brine; which had become weaker, from a portion of the salt of the brine having been absorbed by the fish, and, also, from the natural moisture exuding from it.

That this is all the necessary operation. That the expense of the salt is very little, as Government allows a drawback of the duty, on all salt used in the fisheries.

Mr. London believes that mackarel pickled in common salt would soon putrify. He supposes, indeed, that they may be preserved with the large-grained Cheshire salt; but even this is not equal to the refined salt he uses, which,

from his experiments, contains 570 parts of muriatic acid, 425 parts of soda, and only 5 parts of extraneous matter, in 1000 parts of the salt.

*** IT appeared to the Committee, that a greater portion of salt in lumps was added to the pickle than could be dissolved; and that there always should remain a quantity of lumps of salt undissolved, ready to counteract, by solution, any tendency to putridity which might arise in the fish;—*and that Mr. London's British salt was particularly well calculated for the preservation of fish, from its having been deprived of its impurities, and its water of crystallization, by previous fusion.*

The following additional information was also furnished to the Society by Mr. PHILLIPS LONDON, *on the Pickling of Mackarel &c. and the Preservation of Sprats, by the use of his British solid salt.*

SIR, 57, *Cannon Street, Nov.* 17, 1813.

Herewith you will receive a small cask of mackarel, which have been cured several months. I shall have the pleasure of calling at the Adelphi, to explain why they were not sent sooner.

I am, Sir, your obedient servant,

PHILLIPS LONDON.

To C. TAYLOR, *M.D. Sec.*

SIR, *Cannon Street, Jan.* 29, 1814.

I received your very polite and attentive note; and, in consequence, should have done myself the honour of waiting upon the Gentlemen of the Committee this evening, but am prevented by the severe weather. I therefore beg you to make my apology to them.—The kit of mackarel I sent, was one remaining of the last Spring catching.

I herewith send you a small jar of mackarel in slices, which are said to be nearly equal in flavour to the anchovy. Preparations are made at Ramsgate for curing them upon a large scale, early in the Spring.

I take this opportunity of submitting to the Committee a specimen of *pickled sprats,* cured about six weeks ago in London, after having been caught two or three days. I have just now caused about one hundred barrels, fresh from the sea, to be done at Ramsgate, under the particular notice of Sir W. Curtis, Bart. Some such are now selling to the labouring poor at Spitalfields, under the Association for their relief, *at one penny per pound,* in number about fifty fish. I presume to request the particular attention of the Society of Arts to this important subject.

Your very obedient servant,

PHILLIPS LONDON.

To C. TAYLOR, *M.D. Sec.*

SIR, 57, *Cannon Street, Dec.* 6, 1814.

I BEG of you to present my respectful compliments to the Gentlemen of the Committee, and also to the Society, for their Vote of Thanks, conveyed to me in your Letters of 9th March and 21st of April last; expressing also their hopes that I would persevere in preserving mackarel upon the principle which I had the honour to communicate to them in May 1813, and which, they were pleased to say, they regard as an object of much National consequence.

I have not, Sir, been inattentive to the object: on the contrary, I have caused to be cured, this last season at Ramsgate, *upwards of twenty-five thousand mackarel.*

There were cured at the same place this Autumn, and sent to the West Indies, upwards of three hundred barrels of herrings; and, in the last Spring, about fifty barrels of sprats, all preserved upon the principles which the Society did me the honour so highly to approve; *and which, I am fully persuaded, is the most effectual, economical, and expeditious method of curing fish ever practised:* and I am strengthened in this hope, by observing, in the Fishing Regulation Bill, now depending, that encouragement is held out, by a new clause introduced expressly for the purpose.

In expectation that the mode of curing fish by immersion in fully-saturated brine of solid salt, may become very general, particularly for herrings, I am induced to inclose to the Society the process, more fully explained than it is in their Volume for 1813; and calculated for curing fish on shore, and in any situation, however exposed, even without any covering;—as you will readily conceive, that a surplus of salt on the surface of the brine will always meet, and quickly saturate, any rain whatever, that may fall into the reservoirs. I am, with respect and esteem,

Sir, your obedient servant,

PHILLIPS LONDON.

To C. TAYLOR, *M.D. Sec.*

Process for Curing Herrings, Pilchards, Mackarel, Sprats, &c. by immersion in Brine of British "SOLID SALT."

Reservoirs, of any required size, are to be provided, in the forms of tanner's pits; or backs, vats, or casks, perfectly water-tight; which should be about one-half filled with brine, made with the said salt, of the specific gravity of 1.206., water being 1.000., by dissolving about 28 parts of the salt in 72 parts of fresh water.

The fish, as fresh as possible, may be gutted or not; and, without delay, be plunged into this fully-saturated brine, in such quantity as nearly to fill the reservoirs; and, after remaining therein, quite immersed, for five or six days, they will be effectually struck; and so fully impregnated with salt, as to be perfectly fit for being repacked as usual, with large-grained "SOLID SALT," and exported to the hottest climates.

Brine is known always to be weakest at the upper part. To remedy this, and in order that the brine be kept up to an uniform saturation, a wooden lattice-work frame, of such size as easily to be let into the inside of the reservoir, is sunk an inch or two under the surface of the brine, for the purpose of suspending upon it lumps of one or two pounds weight, or larger, of "SOLID SALT," which will

effectually saturate whatever moisture may exude from the fish; and thus the brine will be continued of the utmost strength, so long as any part of the lumps remain undissolved. The solidity of the lumps admits of their being applied several times, or whenever the reservoirs are replenished with fish; and the brine, although repeatedly used, does not putrify, nor do the fish, if kept under the surface, ever become rancid.

All provisions are best preserved by the above method; particularly bacon, which, when cured by that process, is not so liable to become rusty as when done by the usual method of rubbing it with salt, and yet is most effectually cured.

The solid salt may be procured in any quantity, or of any size, of Messrs. LONDON, at the salt-pit, Northwich, Cheshire; Messrs. SMITH, MARTEN, SMITH & Co. America Square, London; or Messrs. WHITEHOUSE & GALAN, Liverpool.

SIR, *No. 57, Cannon Street, London, Feb. 14, 1815.*

I herewith send you a half barrel of mackarel, part of twenty-five thousand mackarel cured on my plan; also Mr. Cutler's Certificate, that so many were cured at Ramsgate during the last season, most of which were shipped for Russia. They were all cured by immersion in brine of British solid salt, agreeably to the method I had the honour of communicating to the Society, and which is published in the Thirty-second Volume of the Society's Transactions. The whole were extremely fine; and full as beautiful as the specimen sent, which, I hope, will meet the approbation of the Society.

I am, Sir, your obedient servant,

To C. TAYLOR, M.D. Sec. PHILLIPS LONDON.

From Mr. London's statement, at a Meeting of the Committee, it appears that the same process will also answer perfectly well for preserving beef, or any animal food, for sea store.

CERTIFICATE.

Mr. LONDON cured by his new process, under my immediate inspection, upwards of 25,000 mackarel, at Ramsgate, in Kent, during the last season.

JOHN CUTLER, Licensed Fish Curer,

September 28, 1814. At Ramsgate, Kent.

Reference to the Engraving of Mr. LONDON'S *Hydrometers. Plate* VIII. *Fig.* 1.

A glass bottle, with a ground glass-stopper, is to be filled with brine, made from a solution of solid salt in water. The three glass bulbs within it, *a*, *b*, *c*, are of different specific gravities; and so graduated, that, supposing the temperature of the air to be at sixty degrees of Fahrenheit's thermometer, and only one bulb floats on the surface, as shewn in the engraving at *a*, it indicates the specific gravity of the brine to be 1.155; containing about 20 parts of salt, and 80 of water, which is insufficient to cure animal matters with certainty, by immersion in it.

When the second bulb, *b*, floats, it indicates the specific gravity of the brine to be 1.180; or about 24 parts of salt, and 76 parts of water; which may be used for the purpose of immersion.

But when the three bulbs, *a*, *b*, *c*, float, they indicate the specific gravity to be 1.196, or about 28 salt and 72 water.

This brine will fully answer the purpose, in the hottest weather, in most climates; provided the rules be attended to, which I had the honour to send the Society last year, and the meat or fish be always covered with the brine.

PHILLIPS LONDON.

XXXVIII.—*Specification of the Patent granted to* PHILLIPS LONDON *the Elder, and* PHILLIPS LONDON *the Younger, of the Parish of St. Luke, Chelsea, in the County of Middlesex, Gentlemen; for certain new and improved Methods or Processes of manufacturing, refining, and purifying Muriate of Soda, or Common Salt.—Dated April* 19, 1809. *Term expired.*

WE, Phillips London the Elder and Phillips London the Younger, do hereby declare, that our invention or discovery is fully described in manner following; that is to say: It consists in purifying, refining, and manufacturing muriate of soda, or common salt, for general use and purposes; *viz.* rock or fossil salt, salt made from rock or fossil salt, or from brine-springs, sea-water, or muriate of soda, or common salt, in any state, or however made or obtained, by fusion, or by heat, or calcination; and by the application (to it, or its solution) of soda (mineral alkali), its nitrate, sulphate, or carbonate, or any other of its combinations; pot-ash (vegetable alkali), volatile alkali, lime, or their sulphates, nitrates, carbonates, or any other of their combinations; or by the addition of any other material or re-agents, that will effect the decomposition, precipitation, or separation of the whole or part of the earths and metals, or earthy or metallic salts, mixed with or combined with the muriate of soda, or common salt, before mentioned, or any solution thereof, as particular circumstances may suit or require.

The muriate of soda, or common salt, with the necessary re-agents and materials, is to be put into a reverberatory furnace or furnaces, or any suitable furnaces, kilns, pots, pans, or other fit and proper vessel or vessels; and such a degree of heat applied, as will fuse the said muriate of soda, or common salt; (at this period of the process, the re-agents and materials may be applied, if preferred); which, being kept in fusion a sufficient time, so that the earthy and metallic parts be decomposed, precipitated, or separated, it is to be drawn off, or taken out, into proper

receiving-vessels, as long as it continues to come off fit and clear, (or it may remain, to cool in the furnaces, kilns, &c.) leaving the sediment or residue of the precipitated or separated earth and metals, with some muriate of soda, or common salt, in the furnaces, kilns, &c.; afterwards the muriate of soda, or common salt, may be broken for use, into any sized grains or pieces required. But if the muriate of soda, or common salt, be not required in such a state of purity as it may be procured by the aforesaid means, it may be procured, as above, with some, or without any, of the said re-agents or materials; as, by a properly regulated and continued heat, part of the earthy and metallic salts will be decomposed or separated, and the earths and metals precipitated or separated; and the muriate of soda, or common salt, be drawn off, or taken out, &c. as aforesaid. The muriate of soda, or common salt, remaining with the sediment or residue in the furnaces, kilns, &c. we entirely recover, by solution and evaporation; and when the earthy and metallic salts, mixed or combined with the muriate of soda, or common salt, are of the kinds capable of being decomposed or separated by calcination, or by a considerable degree of heat,—and the muriate of soda, or common salt, be not required in such purity, or in such very large pieces or grains, as are obtainable by fusion,—heat or calcination need only be employed; in which case, the muriate of soda, or common salt, may be taken out of the furnace, kilns, &c. for use; or may be refined by the modes usually practised with rock salt, *viz.* solution, decomposition, or evaporation; which mode is also applicable to salt having been fused: and the muriate of soda, or common salt, so refined, will be purer, and more fit for curing fish and provision, and common use, than any small salt at present manufactured.

The muriate of soda, or common salt, manufactured by the aforesaid processes, may be generally used; and it is presumed, that the muriate of soda, or common salt, refined by fusion, may supersede the necessity of importing or using any foreign bay-salt altogether.

XXXIX.—*Mr.* JOHN BARTON, *on further Misrepresentations of his Patent for Improvements in Propelling, &c. by the late* ANONYMOUS JOURNALIST.

SIR, *No. 44, Seward Street, Goswell Street, Sept. 5, 1823.*

I HAD trusted, that my complaints, and your candid statement of my pretensions, would have induced the late anonymous Journalist to make me amends, to the best of his power, for the injuries to which his misrepresentations have so long subjected me. It could not have been supposed, after all that has passed, that he would aggravate the evil, by endeavouring to delude his readers into a belief that his former condemnation of my inventions was correct. I am compelled, therefore, through the medium of your Repository, to appeal once more to the tribunal of public opinion.

He has now (with the exception of *another* misrepresentation) published my specification at full length; and, also, again given *his own misrepresented figures*;—by which means, he himself thus, *unwittingly*, enables every one to see the mischief more clearly.

One of his new misrepresentations consists in an insidious attempt to make the figure of my hollow bucket-rod appear, in the specification, liable to become choked up above, by the rising of the valve from its seat, agreeably to his own misrepresented figure;—and, in order to do this, *he has greatly contracted the space above and around the valve.**

Another misrepresentation consists in an attempt to persuade his readers into a belief, that my hydraulic engine greatly resembles one erected by the late celebrated Mr. Bramah, at the Norwich Water-works, about twenty-five years ago;—thus again endeavouring to deprive me of the merit of originality. It will appear, however, that there are very great differences indeed between the two inventions, and such as, I believe, are fully sufficient to support a Patent for the improvements. Mr. Bramah's engine†

* Copies of these two figures are accurately given in Plate VIII. figs. 2 and 3; and of that in the Specification, on the same scale, in fig. 4.

† See Plate VIII. fig. 5.

consists of two moveable flaps, with a valve in each, working low down in the cylinder, and packed around their edges in the usual manner: whereas mine* *has only a single flap, without any valve in it, which works in the upper part of the cylinder, quite remote from any gravel, &c. which might be drawn into the engine with the water;* for which gravel, &c. an abundant space is provided in the lower part of the cylinder, for it to lodge: and this space is separated from the working part of the cylinder by fixed division plates, with valves in their upper parts. My single flap has likewise springing-out metallic plates around its edges†, similar, in their action, to my patent metallic piston, described in your last Number. The space for the gravel, &c. to lodge in, is totally wanting in Mr. Bramah's engine.

The Journalist endeavours to excuse his former misrepresentations, by saying, "*It must be acknowledged that our drawings in this instance are not so accurate in detail as they ought to be*"—(he might, with equal truth, have added, *nor in generals*). He also confesses, "*that the figures are merely sketches from memory.*" But is it not grievous, that the property of Patentees should be placed at the mercy of *a treacherous memory*;—and that my hydraulic engine should thus be *perverted* into a *vile caricature* of it?‡

I am certain, Sir, that you will be equally astonished with myself, that the Journalist, without any reasonable cause, should thus continue to add injury to injury; and still endeavour, as far as his journal has influence, by detracting from their *originality*, to prevent me from deriving the benefit of my inventions. But surely, after being thus detected of *misrepresentation* and *partiality*, his judgment, and qualifications for deciding upon the merit of others' inventions, must be looked upon with caution and mistrust.

I am, Sir, your much obliged and obedient servant,

JOHN BARTON.

To T. GILL, *Esq.*

* See Plate IV. fig. 7. † See Plate IV. fig. 8.

‡ See Plate IV. fig. 13; and for the Journalist's description of it, see p. 124 of the present volume.

XL.—*Additional Information on the Process of Soldering thin Sheet-Iron with Cast-Iron. By the* EDITOR.

WE had hoped, that we had proved this valuable operation to be a *real Soldering Process* beyond dispute: but it is not so; for there is yet to be found a person who has the effrontery to say "that the process is simply and literally *welding* the edges of the iron together, and not *soldering* them;" "*and the material employed as a flux, does not contain any metallic substance whatever.*"—We shall soon test the correctness of these assertions.

We knew that we could place the most implicit reliance on the truth of Mr. Perkins's statement to our informant, that *the process was effected, by means of filings of soft cast-iron; borax, deprived of its water of crystallization; and sal-ammoniac:* and indeed, it exactly agreed, except in its application to *thin sheet-iron*, with a process we had published in our first volume, p. 432, for soldering *iron*, or *mild* cast-steel, with *cast-iron:* and, as our friend had communicated to us this new application of it *unreservedly*, so we were glad to publish it. It now turns out, that "the discovery is considered as *a valuable secret by the few persons who possess it:*" and, accordingly, every means are to be pursued, to shake the veracity of our statement.

However, to put the matter beyond all dispute, *we have combined borax, deprived of its water of crystallization, with soft cast-iron filings, by fusion in a crucible*; and the result has been, that we have obtained the identical "*hard shining material, which looked something like pitch;*" it being indeed the glass of borax coloured black by the *iron* combined with it, *and which constitutes the whole secret of the process;* for they make no secret of the manner of using it.

We have also witnessed the application of this material, in powder, to *soldering* the overlapped edges of thin sheet-iron together, at *a bright orange heat;* not at *a white heat*, the *welding heat for iron.*

We were exceedingly pleased with *the very great faci-*

lity with which *this highly-valuable process* can be applied in practice.

The powdered *flux* (*and solder*) was laid along a short portion of the *internal* joining or overlapping of the sheet-iron, to which sal-ammoniac had been previously applied; and, instantly on its fusion, the tube was withdrawn from over the clear forge-fire (which was urged with bellows), and the soldered part placed upon a cylinder affixed to the anvil: it was then beaten *with a light hammer, and with blows rapidly succeeding each other*, as long as the heat permitted it to be thinned; when more of the powder was laid upon the adjoining part of the seam, and the process repeated; and so on, until the whole length of the joint was *soldered by the intermediation of the cast-iron*, in a very neat and perfect manner.

We have thus placed it in the power of every one to perform this valuable process; and it will no longer be a secret, known only to a few.

We consider this second attempt to bring it again under the veil of mystery, to be one of those *contemptible charlatanic acts*, which are only calculated to hinder the progress towards perfection in the Arts.

XLI.—*On an Improved Mode of actuating Snuff-Mills, and on applying them to Drug-Grinding. By the* EDITOR.

IN the ordinary Snuff-Mills, as at present constructed, the operation of grinding the snuff is effected in a number of cast-iron mortars, arranged in a circle, the pestles or grinders of which are pulled or dragged around the insides of the mortars by means of chains and loops affixed to them, and to arms, upon the lower ends of as many upright spindles, which have pinions upon them, turned by a large cog-wheel upon an upright shaft; which wheel receives its own motion from the water-wheel, or other first mover of the mills. In this mode, a very great loss of power is occasioned, from the friction of the shoulders of the lower

necks or pivots of the spindles, upon their brasses or bearings.

The Editor has long since advised the removal of this great loss of power, by reversing the action of the parts; that is, by making the mortars themselves revolve, instead of the pestles being dragged around them. This arrangement is shewn in Plate VII. fig. 6, in which *a* is the mortar, mounted upon an upright axis, with a pinion to be driven by the cog-wheel; *b*, the pestle or grinder, the neck or pivot on the upper end of which turns in a fork or groove made at the top of the standard or bracket *c*. The bottom pivot of the axis is made slightly convex, and rests upon the flat steel plate in the *chair*; so that the centre of the axis shall be in contact with the steel plate; and both parts being made of hard steel, the friction will be very trifling indeed. The manner of fitting the chair, with a bell-metal socket, screws, &c. has already been described in our Article "*On Reducing Friction in Machinery*," in Vol. I. p. 454, and need not be repeated.

The advantages of this change in the mode of actuating these mills, must be apparent to every one in the least conversant with mill-work. But this is not all: These mills, so fitted up, are excellently adapted to drug-grinding: and indeed we know of one, fitted up in the old way, and needlessly encumbered with no less than *seven toothed wheels, two of them being bevel-wheels*, in order to be turned by a winch or handle, actuated by one man; and yet does its work to the complete satisfaction of the owner; although, we must confess, not so much to the comfort of the labourer who turns it. Now all this useless complication of wheel-work may be entirely dispensed with; and the mortar be made to revolve by a crank upon its axis, to be worked by a person seated in the *rowing posture*, as described in the Observations in our last Number, p. 142, "*On Prison Labour.*"

In case of making the mortar on a large scale, it would be well to turn it by means of two cranks on the axis, at right-angles to each other, to be worked by two or more

persons; and, should there not be sufficient *momentum* in the mortar itself, a fly-wheel might very conveniently be affixed on the lower end of the axis; which might be floored over, to allow convenient access to the mortar.

The present mode of actuating Snuff-Mills, is shewn in dotted lines, in the upper part of the Plate.

XLII.—*On Bronze Statues, and Medals; and on Cannon, Bells, &c.*

(Concluded from p. 189.)

By this process, a great part of the scoriæ are brought into use which were formerly thrown upon the roads, as we have before mentioned: nevertheless, some scoriæ were so loaded with earthy substances, as to be considered of no value; at least, the persons usually employed in the reduction of the scoriæ, thought they could not act upon them to any advantage. M. Bréant, however, who has but lately begun to operate upon the scoriæ of bell-metal, has carried this operation to a pitch of very great perfection; so that he can work with advantage a considerable proportion of that which had been rejected by others. This mode of operating has not yet been made public, but he promises it soon shall be; and has willingly communicated the basis on which the advantage of his process is founded: it appears, in fact, a very superior one; of which some judgment may be formed from the following outlines:

In order to reduce those scoriæ which are rich in tin, M. Bréant employs a greater quantity of charcoal than usual; and increases their fusibility by the addition of powdered oyster-shells, broken glass bottles, or even vitrified scoriæ, and operates upon them in a reverberatory furnace.

When the metal obtained is rich in tin, he exposes it to a fire, on the bed of a reverberatory furnace; where, by the aid of a heat regulated according to the relative proportions of the metals in the alloy, he procures a true liquation, by means of which the tin is entirely separated.

Metallic drops are seen to form around the edges of the mass, which run in globules down the inclined plane of the furnace-bed; and the fluid metal is collected in a cavity, from whence it is removed to be cast into ingots.

When the alloy thus treated contains lead, it is found in the first parts which are liquified: the tin is next extracted; and the last part fused contains a greater or lesser quantity of copper. The products, therefore, may be thus divided: —the first, tin containing lead; then tin considerably purer; lastly, tin alloyed with copper.

A spongy mass remains, which generally affords beautiful crystallizations: this mass, commonly too rich in copper for the tin to separate by liquation, is operated upon by means of oxidation.

By this process, we perceive that M. Bréant greatly diminishes the number of reductions and oxidations; and, consequently, does not sustain that enormous loss in tin, which becomes volatilized by a long exposure to a current of air at so elevated a temperature: he uses less fuel; his expenses in labour are considerably less; his operations are not so numerous; and he either obtains purer results, or those whose composition is well known, and only binary, and therefore may be readily employed in the different arts to which they are most suitable.

In this manner M. Bréant has advantageously treated more than a million of kilogrammes of scoriæ, producing a profit of 40 centimes in the 100 kilogrammes; whereas, before his improvements, many millions of these substances, much richer in metal, were sold for only 5 centimes for the 100 kilogrammes.

Analysis of Bronze.—If we know not, from the nature of the bronze article, what are the metals which enter into its composition, they may be thus ascertained:—

A sample of it is either reduced into grains, or into laminæ, by means of a flatting-mill; a portion of it is then dissolved in nitric acid: all the metals constituting the bronze (such as the copper, zinc, lead, and iron), being dis-

solved; the tin precipitates itself, in the form of a white powder; and the solution is tested by proper re-agents. Then proceed in the following manner.

If the alloy to be assayed contains only copper and tin, (which is frequently the case with the alloy for medals, cymbals, gongs, cannon, and many other articles,) we weigh, accurately, a certain quantity of the bronze, reduced into laminæ or grains, (10 grammes for instance,) and put it into a small matrass or phial; we then pour upon it 60 grammes of pure nitric acid, at about 30 degrees, and place it over a small furnace; then, by means of burning charcoal, the temperature is gradually raised; the nitric acid is decomposed, by acting upon the alloy; a part of its oxygen acts at once upon the copper and the tin; and there results from this decomposition, and from the action of the nitric acid, the peroxide of tin, which is white and insoluble, and is precipitated in the liquid: the nitrate of copper which remains in solution, the ammonia, and the deutoxide of azote, coming into contact with the air, are disengaged in the form of red vapours. When we find that the metallic particles are not altered, and that no gas is any longer disengaged, although the liquid may be boiling, the decomposition is effected*. The solution must afterwards be evaporated nearly to dryness, in order to drive off the excess of acid: it is then to be diluted with water, and poured upon a filter; and we must collect, by repeated washings with water, all the particles of oxide of tin which may remain adhering to the vessel.

The proper filter for the above process is made of good blotting-paper, previously prepared by washing it with weak nitric acid and well drying it; the exact weight of which must be ascertained, before using it: or this precaution may be rendered unnecessary, by folding two filters at once, then separating them, and rendering their weight equal, by reducing the heaviest by cutting or clipping it; when

* If, however, it happens that the alloy has not been entirely acted upon, and there is no longer any appearance of action, a small quantity of nitric acid may be added.

they may be placed one within the other. If, during the course of the operation, they are found equal in weight, we may believe that they have been exactly equalized: it would then be useless to weigh either of them, as the exterior filter always serves as a *tare* for the interior one*.

The residuum which is deposited upon the filter must be washed with pure water, until the filtered water no longer reddens the tincture of litmus. The two filters may be dried together, and then separated; and we obtain, on weighing them separately, or putting one into each scale of the balance, a difference of weight, which indicates the exact weight of the dried precipitate. But, as this precipitate still contains a little water, we must calcine to redness a part of it, in a small platina crucible; and the loss sustained by this quantity, when deducted proportionally to the whole weight of the precipitate obtained, shews the loss of weight of the real peroxide of tin. Now this oxide is composed of,—

Oxygen	21.39
Tin	78.61
	100.

We may know the quantity of tin, by multiplying the given weight by 78.61, and dividing this product by 100. If this assay be well made, we may ascertain the quantity of copper from that of the tin; since the two constitute the whole quantity of the alloy assayed.

If, nevertheless, on the other hand, we would ascertain the quantity of copper, we must collect all the solutions, and the washing-waters; then decompose the nitrate of copper which they contain, by pouring into them an excess of hydrate of pot-ash or soda (solution of pot-ash or caustic soda); and wash, by decantations, the precipitates of the hydrate and deutoxide of copper which are formed, until

* If the paper has not been well chosen, it may happen that a part of the precipitate may pass through the first filter, and, remaining on the second, may influence the result; which, as we may well conceive, becomes by this means quite inaccurate.

the washing-waters cease to change paper coloured by mallow flowers to a red or blue colour, or to redden litmus paper. The precipitate must then be collected, and calcined to redness, to transform it into the deutoxide of copper: then weigh it, and determine, from its weight, the quantity of pure copper which it represents:—the deut-oxide of copper is composed of,

Copper	80
Oxygen	20
	100

But if the alloy assayed contains *copper, tin, zinc, lead,* and by accident a little *iron,*—like to the composition of the bronze statues by the Brothers Keller, and also of some ornaments of gilt bronze, and of many others of the ancient articles in bronze,—it must be assayed by the following process:

The tin must first be separated, as in the preceding alloy: the other metals will be contained in the solution, and in the washing-waters, when united and evaporated.

After being diluted with water, we must add a solution of sulphate of soda, or potash, until precipitation ceases: by this means, all the lead will be separated, in the state of a sulphate, and precipitate in the form of a white powder: we separate this precipitate by means of a filter and careful washings, with the precautions before indicated. From the weight of the sulphate of lead, we learn the quantity of lead which was contained in the alloy; knowing the composition of this sulphate, which is as follows:

Oxide of	Lead	68,252
	Oxygen . .	5,362
Sulphuric acid . . .		26,386

= 100

We collect the whole of the solutions and the washing-waters; and add an excess of ammonia, which precipitates the oxide of iron in flakes of a reddish-brown colour; the oxides of copper and zinc being held in solution: and then separate the precipitate by the filter, and wash it with dis-

tilled-water. We again unite the solution and the washing-waters, and add an excess of potash; then evaporate the mixture in order to drive off the ammonia; and adding water to the residuum, the whole is brought to a boiling heat, the oxide of zinc is re-dissolved, and the oxide of copper remains insoluble: having collected it on the filter, its weight is ascertained to be equivalent to the copper, as we have before stated; and from the weight of the tritoxide of iron, that of the iron is in like manner inferred*: To ascertain the quantity of zinc, a small excess of hydrochloric or sulphuric acid must be added, which will transform the potash, and the oxide of zinc, into hydrochlorates or sulphates; then add sub-carbonate of potash or soda, which precipitates all the oxide of zinc united to the carbonic acid: this precipitate, being collected, washed, dried, and calcined in a red-heat, will be decomposed; and nothing remains but the oxide, from which we learn the quantity of zinc; as the oxide is formed of zinc 100, and oxygen 24.797.

As this latter part of the process, the object of which is to obtain the zinc, is rather complicated, and consequently subject to error, M. D'Arcet employs a more expeditious method.

He weighs one gramme of the alloy intended to be assayed; and, if possible, procures this weight in one single piece; which is wrapped up in a piece of paper, that it may be found the more readily after the operation. It is then put into a small crucible, surrounded with charcoal very finely powdered: the crucible being closed with an earthen cover, and luted†: it is then heated, by being placed in a muffle of a cupelling-furnace; the lead and the zinc are disengaged: and the weight of the piece of metal

* In the tritoxide of iron, 100 parts of this metal are united with 42.31 of oxygen, according to M. Thénard; or 44.224, according to Berzelius.

† When the luting dries, it leaves cracks, which must be carefully stopped up; as without this precaution the air might find a passage into the crucible, by which the charcoal would become burnt, the metal oxidated, &c.; in fact, we suspect that the operation would entirely fail.

is consequently diminished: it is withdrawn from the fire before the time that its loss of weight is at its *maximum*, and then weighed; then returned to the fire, and again withdrawn from it and weighed; and these operations are repeated, until its weight, after having presented a gradual diminution in two or three weighings, increases one or two *millièmes*. This augmentation is owing to a combination which takes place between the copper and the charcoal, when all the zinc and the lead are removed: this is the exact moment which must be seized, to ascertain the loss arising from the volatilization of the zinc; an account must then be correctly taken, of the *maximum* only of the loss, which will represent the weight of the zinc: and that of the copper and tin is known, according to the analysis made in the humid way, as above described.

If the alloy assayed contained lead, this metal would disappear with the zinc; but the process would be equally applicable: in fact, the quantity of lead being beforehand determined by means of the analysis in the humid way, we subtract its weight from the loss observed, and the difference will point out the weight of the zinc.

This process, which may appear difficult to follow exactly, on account of the numerous trials to be made, is yet very easy to those accustomed to it. The assays of bronze, on certain occasions, have been very numerous in the laboratories of the Mint, and are effected in this manner; which has become so habitual to those employed, that, in their calculations, they never vary half a thousandth part.

XLIII.—*On the Advantages attending the Employment of the Patent Metallic Pistons, and Metallic Substitutes for Stuffing-Boxes, invented by* Mr. JOHN BARTON.

[Concluded from p. 212.]

IN Plate IX., figs. 1 and 2, the Metallic Substitute for Stuffing-boxes is represented in two cross sections, as was the piston described in our last Number, the one vertical

through the dotted line A A in fig. 2; and the other horizontal, through the line B B in fig. 1. C, in both figures indicates the piston-rod—D, the cylinder—E, a recess or cavity made in it, for the cast-iron plate F, to lodge in —G, another above, to receive the cast-iron plate H—I, the cover of the cylinder, secured by screws and nuts, to the flange on the end of the cylinder—J, and K, plates of lead, introduced for the purpose of making the joints closer—L L, &c., the three principal metal blocks, which embrace the piston-rod—M M, &c., the three secondary blocks, which fill up the small spaces left between the junctions of the principal blocks,—N N, &c., two thin hoops or bands made of hardened and tempered steel, firmly riveted together at their ends; these surround the six blocks, lodging upon the rounded exterior angles of the blocks, which are filed away to receive them; leaving however, a solid part in the middle of each, (two of which are shewn in fig. 1, at O O,) to keep the bands in their places. The exterior angles of the blocks, which, at first, would all touch a circle described around them, are, however, filed away less on the exterior angles of the blocks L L, &c., than they are on those of the blocks M M, &c.; the consequence of which is, that the blocks L L, &c., are more strongly compressed towards the piston-rod, by the action of the elastic bands upon them, than the secondary ones N N, &c., are; nevertheless the bands do exert a proper degree of pressure upon the latter blocks also. In addition to the power of the elastic bands, six helical springs, P P, &c. lodged in cylindrical holes, made in the blocks L L, &c., also thrust both against the bands and those blocks, and unite in pressing the latter into contact with the piston-rod; they have steel cylindrical pins within them, as in the piston before described.—Q Q, are two other bands, rings, or hoops of elastic steel, cleft across, and which serve to close the joints more perfectly around the piston-rod; they are lodged in grooves made in the inner ends of the blocks L L, &c. and are fixed in a similar manner to the rings around the piston before described.—A

middle groove R, is also formed between the two others, to receive grease, or other lubricating materials; and a circular cavity S S, is also made around the hole in the cover of the cylinder, for the same purpose.

These inventions manifest *a combination of mechanical talents rarely indeed exhibited;* and we feel ourselves perfectly justified in laying before our Readers the fullest particulars relative to them.

XLIV.—*A fair and liberal Proposal to Mr. Perkins, to ascertain the Powers of his new Steam-engines, by actual Experiments. By* B. BEVAN, *Esq. Civil Engineer.—With Mr. Perkins's acquiescence thereto.*

DEAR SIR, *Leighton Buzzard, Sept.* 17, 1823.

THE flourishing account you have given*, of the great discoveries of Mr. Perkins, is almost sufficient to surprise many of the *would-be* Mechanics; and I can assure you that it will afford me the highest pleasure to find the great promises realized. I am however afraid, that Mr. Perkins will, by promising more than he is able to perform, injure his credit, which is already very great.

Not having had an opportunity of seeing the engine, it would not be right in me to give a positive opinion of its real merits; but I may take this opportunity of giving *a challenge* to Mr. Perkins, to let his engine be *fairly* tried for *ten hours*, under close inspection, with a given quantity of coals, performing actual work, such as that of raising water to a known height; and, if the result should not prove 16 to 1 in favour of the new engine, but 2 to 1, Mr. Perkins will have great reason to exult, in having established the merits of his engine, as superior to those of Boulton and Watt.

Yours respectfully,

T. GILL. *Esq.* B. BEVAN.

*From the Edinburgh Quarterly Philosophical Journal.—EDITOR.

We have communicated Mr. Bevan's proposal to Mr. Perkins; and he desires us to assure Mr. Bevan, that nothing could afford him greater pleasure, than to be able to satisfy him, and the public in general, of the powers of his steam-engine from actual trial: and he is now actually constructing one, of ten horse power, to be applied in pumping water: which will be completed with all possible expedition.—EDITOR.

XLV.—*Answer to the Queries, "On Artificial Fountains." By* B. BEVAN, *Esq. Civil Engineer.*

DEAR SIR, *Leighton Buzzard, Sept.* 13, 1823.

OBSERVING, in your very useful Repository, No. XX. p. 140, some Queries respecting the present mode of Boring for Water,—and finding none of your Correspondents have noticed the subject in the last Number,—I take the liberty of sending a few observations, in reply to the said Queries, in case you may not be already furnished with more useful particulars.

From the manner in which the art of obtaining water has been often mentioned, it might be supposed that it might be practised with success in any situation; whereas the possibility of succeeding is confined to certain districts, and depends upon the succession of the strata and the elevation of the surface; requiring an impervious stratum of moderate thickness, resting upon an open stratum charged with water, from a source of greater elevation than the surface of the spot to be bored.

If the sub-stratum is altogether porous, and open to the passage of water, it will be in vain to look for a supply above the natural outlet of the springs in the vicinity: and if the relative height of the situation, where water is required, to the outcrop of the underlying porous stratum, should not be favourable, it will also be in vain to bore: but should the surface of the district be low, and have a substratum of clay or marl to a moderate depth, an aperture made through

the clay to the confined water below, will allow it to rise to the surface, and in some instances to rise many feet above the surface, up pipes properly fixed for that purpose.

At Cambridge, where this practice is very common, the substratum, after passing through the alluvial gravel and soil, is the chalk marl, or, what is commonly in that place called *gault*, and is about from 120 to 130 feet in thickness, resting upon a stratum of sand saturated with water, the outcrop of which is at a considerable distance, and much above the level of Cambridge: any opening therefore through this marl, or gault, will allow the confined water to rise; but, if no further precaution was used, it would reach the surface indeed, but, upon coming to the alluvial gravel, would be diffused in that reservoir of water constituting the more superficial springs, which are often, without any good reason, called land-springs:—therefore, to secure a supply at the surface, it is *essential* to cut off all communication with these higher springs; and this is usually done by inserting an iron pipe several feet into the water-tight stratum, and puddling or ramming strong clay round the lower part, and continuing the pipe, by additions, as may be required, until it reaches the intended place of delivery. The hole is then bored through the clay with an auger of about four inches in diameter; and when cleared of the mud and softened clay, produced by the operation of boring; a tin tube, as large as the hole will admit, is passed from the top to the bottom, to keep open the aperture first made; and afterwards the fountain-head is fixed upon the iron pipe.

The boring-rods are generally about one inch square, of bar-iron, screwed together in lengths of 6 to 12 feet. Sets of joints may be obtained at any general iron-factory, and welded to bars of any length. The cost of rods and joints, ready for use, will be about 5*s.* per yard; and the total expense of the operation, including the use of all the implements, and iron and tin pipes, to holes of 130 feet deep, is about 25*l.*

It occasionally happens, that thin beds of rock are found,

in boring, too hard for the auger: these are cut through by a piece substituted for the auger, in the shape of a chisel; worked continually round, in a stamping motion, until the rock is perforated: this tedious process sometimes requires two or three days to pass a rock of eight or nine inches in thickness.

The quantity of water produced at one of these apertures lately made at Cambridge, is regularly 12 gallons per minute; and at another finished this week, full 11 gallons per minute.

I am, Dear Sir, your obedient servant,

B. BEVAN.

T. GILL, *Esq.*

XLVI.—*On the great convenience of employing the Economical and Portable Boilers, and Pumice-Stone Furnaces. Invented by the* EDITOR.

WE have now used the Portable Boiler, and Pumice-stone Furnace, described in our last Number, p. 156, for nearly two months; and, indeed, with MM. Thenard and Fourier, "*intend constantly to use them, as they are attended with an economy in time and fuel;*"—an economy so great, that, without actual experience, we could hardly have credited it;* and the *convenience*, if possible, even exceeds the *economy*. We are now rendered, by the use of them, entirely independent of any one, in heating the water for shaving; which, to us, is indispensably requisite; as we find that the hotter the water is, into which the razor is dipped; the easier and closer is the shaving accomplished.

We have described the hemispherical cavity in the pumice-stone furnace, *as being only two and a half inches in diameter, and an inch and a half deep; and, consequently, the quantity of charcoal it can hold must be small indeed: but even of this small quantity, not more than a third part is consumed at each time of using;* the remainder nearly filling the cavity, and requiring only the addition of three or four fresh pieces at the time of using the furnace.

* It appears, from our experience, that the expense of charcoal for a whole year, *would not exceed one shilling.*—EDITOR.

We hold the furnace in the left-hand, and kindle the coals, as before observed, by directing the flame of a candle upon them with the help of a blow-pipe; and when there are several adjoining pieces ignited, we place the furnace on the flat and level side, or hob of the grate, and excite the fire by blowing with the mouth; the boiler is then placed upon it, filled with water; and every now and then, if we find the fire becoming low, as is sometimes the case, we refresh it, by blowing into the gap made in the side of the furnace; and thus, without any farther trouble or attention, the water, in a few minutes, becomes boiling hot: we then remove the boiler, and employ the water as required.

In the mean time, the fire in the furnace will gradually become extinguished; and the furnace may be laid aside, ready for use next day. The very trifling quantity of white ashes, diffused around the furnace by blowing the fire occasionally, are all the tokens which remain, to shew that a fire has ever been kindled at all; and they, of course, are readily got rid of on removing the furnace, by merely blowing them into the fire-place or grate.

In short, as we have said before, without actual experience, we could not possibly have conceived *that so useful and convenient an apparatus could have been employed, with so very little trouble and expense;* and can only regret, that we did not become acquainted with its valuable properties many years ago.

There can now be no manner of doubt, that a similar apparatus, only made on a larger scale, must be equally beneficial, when employed in heating water for making tea, cooking, &c., as described by MM. Thenard and Fourier.

When a larger fire is required, the use of *pumice-stone* for the furnace becomes unnecessary: it is only when so very small a one as we have described is employed, that *the invaluable slow-conducting power of pumice-stone for heat* becomes manifest; and, indeed, without employing that material, we conceive it would be totally impossible to keep the fire ignited.

XLVII.—*Description of the Columbian High-Pressure Steam-Engine, invented by the late* Oliver Evans *of Philadelphia, U. S.—And, On the Origin of Steam-Boats and Steam-Waggons. By the same.*

WITH A PLATE.

References to Plate X.

A, the boiler—B, the working cylinder—C, the lever beam—D, the fly-wheel—E, the cistern or condenser—F, the cold-water pump—G, the supply-pump—H, the fire-place—I, the chimney flue—K, the safety-valve, which may be loaded with from 100 to 150*lbs.* to the inch area: it will never need more, and it must never be fastened down.

Operation.

The boiler being filled with pure water (rain or distilled water) as high as the dotted line, and the fire applied, the smoke enters the centre flue*, which passes through the centre of the water to ascend the flue I, and thus acts on a large surface.

When the steam lifts the safety-valve it is let into the cylinder by opening the throttle-valve, and drives the piston up and down, which by the rod 1, gives motion to the fly-wheel; and the wheel, 2, gives motion to a shaft, passing through the supports of the cylinder, to turn the spindle of the rotary-valves 3, 8, which let the steam both into and out of the cylinder, at the proper time.

The steam, escaping by the pipe 4, curved backwards and forwards in a zigzag form, and immersed in the water in the cistern E, (which is supplied by the cold-water pump F), is condensed; and the distilled water formed thereby, descends, by the pipe 5, into the supply-pump G; and is forced into the boiler again, by the pipe 6.

But as boiling disengages air from the water, so the snifting-valve, 7, is necessary. This valve lifts at every puff of the steam, and a small quantity of air escapes; and

* Latterly, the boiler had no centre flue.—Editor.

it shuts, and a vacuum is instantly formed as the crank passes the dead points.

The small waste of water may be replaced, by condensing part of the steam rising from the condensing water in the cistern E, and causing it to run down the pipe 9, through a hole in the key of a stop-cock, $\frac{1}{32}$ part of an inch in diameter;—a small hole, indeed, to supply a boiler of a steam-engine of twenty horses power.

No sediment can accumulate in the boiler, it being supplied with distilled water; therefore it will last much longer, and require less fuel than others. Muddy water, salt water, or the juice of the sugar-cane, &c. &c. may be used to condense the steam; and, as the engine works equally well, while the condensing water boils away, so it may be evaporated for obtaining salt, sugar, &c. whilst working the engine: thus using the fuel for double purposes.

If the steam be confined by the load on the safety-valve, so as to raise its power to 100*lbs.* on the inch area; the cylinder and piston be nine inches in diameter, and the stroke of the piston three feet; the power of the engine will be equal to that of twenty horses; and it will grind twenty bushels of grain *per* hour, or saw 5000 feet of boards in twelve hours. If the steam be confined by 150*lbs*, the power of the engine will be equal to thirty horses, when the steam is shut off at one third of the stroke, and the engine making thirty-six strokes *per* minute.—Double strokes double the power.

The more the steam is confined, and the shorter it be shut off by the regulator 8, the greater will be the power obtained from the fuel; for every addition of thirty degrees heat to the water doubles the power: so that doubling the heat of the water increases the power about a hundred times. On these principles, fuel may be lessened to one-third part of that consumed by other engines. This engine is not more than one-fourth the weight of others: it is more simple, durable, and cheap; and is especially suited for propelling boats and land-carriages. It requires no more

water to supply the loss by waste, than the fuel will evaporate in steam from the condenser; and this steam may be also employed to warm the apartments of factories. The condenser E, could also be used as a still, to distil spirits; as a vat for paper-making or dyeing; as a boiler in a brewery*; &c. &c. OLIVER EVANS.

On the Origin of Steam-Boats and Steam-Waggons.

About the year 1772, being then apprenticed to a wheelwright, I laboured to discover some means of propelling land-carriages, without employing animal power. All the modes that have since been tried (so far as I have heard of them), such as, the wind, treadles with ratchet-wheels, cranks, &c, to be worked by men, presented themselves to my mind; but were considered as too futile to deserve an experiment: and I concluded, that such motion was impossible, for want of a suitable original power.

But one of my brothers informing me, on a Christmas evening, that he had that day been in company with a neighbouring blacksmith's boys, who, for amusement, had stopped up the touch-hole of a gun-barrel, then put into it about a gill of water, and rammed down a tight wadding; after which they put the breech-end of it into the smith's fire, when it discharged itself with as loud a crack as if it had been loaded with gunpowder.

It immediately occurred to me, that here was a power capable of propelling any waggon, provided that I could apply it; and I set myself to work, to find out the means of doing so. I laboured for some time without success: at length, a book fell into my hands, describing the old atmospheric steam-engine. I was astonished to observe, that they had so far erred, as to use the steam only to form a vacuum to apply the mere pressure of the atmosphere, instead of applying the elastic power of the steam for original motion;—a power, which, I supposed, was irresistible.

* The wort in Whitbread's Brewery was heated by high-pressure steam, precisely in a similar manner, by Messrs. J. and P. Taylor.—EDITOR.

I renewed my studies with increased ardour; and soon declared, that I could make *steam-waggons*, and endeavoured to communicate my ideas to others: but, however practicable the thing appeared to me, my object only excited the ridicule of those to whom it was made known. But I persevered in my belief; and confirmed it by experiments, that satisfied me of its reality.

In the year 1786, I petitioned the Legislature of Pennsylvania for the exclusive right to use my improvements in *flour-mills**, as also steam-waggons, in that State. The Committee, to whom the petition was referred, heard me very patiently, while I described the *mill* improvements; but my representations concerning *steam-waggons* made them think me insane. They, however, reported favourably respecting my improvements in the manufacture of flour; and passed an act, granting me the exclusive use of them, as prayed for. This was in March 1787, but no notice is taken of the *steam-waggons*.

A similar petition was also presented to the Legislature of Maryland. Mr. Jesse Hollingsworth, from Baltimore, was one of the Committee appointed to hear me, and report on the case. I candidly informed this Committee of the fate of my application to the Legislature of Pennsylvania, respecting the *steam-waggons*—declaring, at the same time, without the encouragement prayed for being granted to me, that I would never attempt to make them: but that, if they would secure to me the right as requested, I would, as soon as I could, apply the principle to practice; and I explained to them the great elastic power of steam, as well as my mode of applying it to propel waggons. Mr. Hollingsworth very prudently observed, that the grant could injure no one; for he did not think that any man in the world had thought of such a thing before: he therefore

* Many of these valuable improvements, if not all of them, are highly deserving of being applied in this country. We shall hereafter bring some of them within the notice of our Readers.—EDITOR.

wished the encouragement might be afforded, as there was a prospect that it would produce something useful. This kind of argument had the desired effect; and a favourable report was made May 21, 1787; granting to me, my heirs, and assigns, for 14 years, the exclusive right to make and use my improvements in flour-mills, and the steam-waggons, in that State. From that period, I have felt myself bound in honour to the State of Maryland, to produce a steam-waggon, as soon as I could conveniently do it.

In the year 1789, I paid a visit to Benjamin Chandler and Sons, clockmakers—men celebrated for their ingenuity—with a view to induce them to join me in the expense and profits of the project. I shewed to them my drawings, with the plan of the engine, and explained the expansive power of steam; all of which they appeared to understand; but, fearful of the expense and difficulties attending it, declined the concern. However, they certified that I had shewn them the drawings, and explained the powers of high-pressure steam, &c.

In the same year, I went to Ellicott's Mills on the Patapsco, near Baltimore, for the purpose of endeavouring to persuade Messrs. Jonathan Ellicott and Brothers, and their connections, (who were equally famous for their ingenuity,) to join me in the expense and profits of making and using *steam-waggons.* I also shewed them my drawings, and minutely explained to them the powers of steam: they appeared fully to comprehend all I said; and, in return, informed me of some experiments they themselves had made, one of which they shewed me. They placed a gun-barrel, having a hollow arm, and a small hole on one side, at the end of the arm; similar to *Barker's* rotary-tube mill; a little water being put into this barrel, and fire applied to the breech of it, the steam issued from the hole in the end of the arm with such force, as, by re-action, to cause the machine to revolve, as I judged, about one thousand times in a minute, for the space of about five minutes; and with a considerable force, for so small a ma-

chine*. I tarried here two days (May 10th and 11th, 1789) using my best efforts to convince them of the possibility and practicability of propelling waggons, on good turnpike roads, by the elastic power of steam. But they also feared the expense and difficulty of the execution, and declined the proposition. Yet they highly esteemed my improvements in the manufacture of flour, and adopted them in their mills, as well as recommended them to others.

In the same year I communicated my project, and explained my principles, to Levi Hollingsworth, Esq. now a merchant in Baltimore. He appeared to understand them; but also declined a partnership in the scheme, for the same reasons as the former persons.

From the time of my discovering the principles, and the means of applying them to use, I often endeavoured to communicate them to those I believed might be interested in their application to waggons or boats. But very few could understand my explanations, and I could find no one willing to risk the expense of the experiment.

In the year 1785 or 1786, before I had petitioned the Legislatures, I fell into company with Mr. Samuel Jackson, of Redstone; and learning of him, that he resided on the Western Waters, I endeavoured to impress upon his mind, *the great utility and high importance of steam-boats*, to be impelled on those waters; telling him that I had discovered a steam-engine, so powerful, according to its weight, that it would, by means of *paddle-wheels* (which I described to him), readily drive a vessel against the current of those waters, with so great a speed as to be highly beneficial. Mr. Jackson proves that he understood me well; for he has lately written letters, declaring, that about twenty-six years before their date, I described to him the principles of the steam-engine, which I have since put into operation to drive mills, which he has seen—and that I also explained

* Mr. Trevethick, a few years since, obtained a Patent in this country, for a somewhat similar invention to this.—EDITOR.

to him, my plan for propelling boats by my steam-engine, with *paddle-wheels*; describing the very kind of wheels now used for this purpose; and that I then declared to him, my intention to apply my engine to this particular object, as soon as my pecuniary circumstances would permit.

In the year 1800, or 1801, never having found a person willing to contribute to the expense, or even to encourage me to risk it myself; it occurred to me, that, although I was then in full health, I might be suddenly carried off by the yellow fever, that had so often visited our city, (Philadelphia,) or by some other disease or casualty, to which all are liable; and that I had not yet discharged my debt of honour to the State of Maryland, by producing the steam-waggon. I determined, therefore, to set to work the next day, and construct one. I first waited upon Robert Patterson, Esq. Professor of Mathematics in the University of Pennsylvania, and explained to him my principles, as I also did to Mr. Charles Taylor, steam-engineer, from England. They both declared these principles to be new to them, and highly worthy of a fair experiment; advising me without delay, to prove them, in hopes that I might produce *a more simple, cheap, and powerful steam-engine, than any in use.* These gentlemen were the only persons who had such confidence, or afforded me such advice.—I also communicated my plans to B. H. Latrobe, Esq. at the same time; who publicly pronounced them chimerical, and attempted to demonstrate the absurdity of my principles, in his Report to the Philosophical Society of Pennsylvania, on steam-engines; in which same report, he also attempts to shew the impossibility of making steam-boats useful, on account of the weight of the engine; and I was one of the persons alluded to, as being seized with the *steam mania*; in conceiving that waggons and boats could be propelled by steam-engines*. The liberality of the members of the

* The following are the passages alluded to in Mr. Latrobe's Report:—

"During the general lassitude of mechanical exertion which succeeded the American Revolution, the utility of steam-engines appears

Society, caused them to reject that part of his report, which he designed to be demonstrative of the absurdity of my principles; saying, *they had no right to set up their opinions as a stumbling-block, in the road of any exertions to make a discovery.* They said, I might produce something useful, and ordered it to be struck out. *What a pity they did not also reject his demonstrations respecting steam-boats! For, notwithstanding them, they have run, are now running, and will run. So has my engine, and all its principles succeeded. And so will land-carriages, as soon as these principles are applied to them.*

In consequence of the determination above alluded to, I hired workmen and went to work to make a steam-waggon, and had made considerable progress in the undertaking, when the thought struck me; *that, as my steam-engine was entirely different in form, as well as in its principles, from all*

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appears to have been forgotten; but the subject afterwards started into very general notice, *in a form in which it could not possibly be attended with much success. A sort of mania began to prevail, which indeed has not yet entirely subsided, for impelling boats by steam-engines.* Dr. Franklin proposed to force forward the boat by the immediate action of steam upon the water.—(See his Works). Many attempts to simplify the working of the engine, and more to employ a means of dispensing with the beam, in converting the libratory into a rotatory motion, were made. For a short time a passage-boat, rowed by a steam-engine, was established between Bordentown and Philadelphia; but it was soon laid aside. The best and most powerful steam-engine which has been employed for this purpose,—excepting perhaps one constructed by Dr. Kinsey, with the performance of which I am not sufficiently acquainted,—belonged to a few gentlemen of New-York. It was made to act, by way of experiment, upon oars, upon paddles, and upon flutter wheels. *Nothing in the success of any of these experiments appeared to be a sufficient compensation for the expense, and the extreme inconvenience of the steam-engine in the vessel.*"

"*There are indeed general objections to the use of the steam-engine for impelling boats, from which no particular mode of application can be free.* These are, 1st. The weight of the engine and of the fuel. 2d. The large space it occupies. 3d. The tendency of its action to rack the vessel and render it leaky. 4th. The expense of maintenance. 5th. The irregularity of its motion, and the motion of the water in the boiler and cistern, and of the *fuel-vessel* in rough water. 6th, The difficulty arising from the liability of the paddles or oars to break, if light, and from the weight, if made strong. *Nor have I ever heard of an instance, verified by other testimony than that of the inventor, of a speedy and agreeable voyage having been performed in a steam-boat of any construction. I am well aware*

others in use, that I could obtain a Patent for it, and apply it to mills, more profitably than to waggons; for, until now, I apprehended, that as steam-mills had been used in England, I could only obtain a Patent for waggons and boats. I stopped the work immediately, and discharged my hands, until I could arrange my engine for mills; having laid aside the steam-waggon for a time of more leisure.

Two weeks afterwards, I commenced the construction of a small engine, for a mill to grind plaister of Paris.—The cylinder six inches in diameter, and the stroke of the piston eighteen inches—believing, that, with one thousand dollars I could fully try the experiment. But before I had done with experiments, I found that I had expended three thousand seven hundred dollars—all that I could command! I had now to begin the world anew, at the age of forty-eight, with a large family to support. I had calcu-

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aware, that there are still many very respectable and ingenious men, who consider the application of the steam-engine to the purpose of navigation, as highly important, and as very practicable, especially on the rapid waters of the Mississippi; and who would feel themselves almost offended at the expression of an opposite opinion. And perhaps some of the objections against it may be obviated. That founded on the expense and weight of the fuel may not, for some years, exist on the Mississippi, where there is a redundance of wood on the banks: but the cutting and landing will be almost as great an evil.

"*I have said thus much on the engines which have been constructed among us for the purpose of navigating boats, because many modes of working and constructing them have been adopted, which are not used in Europe. Not one of them, however, appears to have sufficient merit to render it worthy of description and imitation*; nor will I, unless by your further desire, occupy your attention with them.

It may not, perhaps, be matter of astonishment, that in the United States of America, twenty years since, and where the Arts had not made that considerable progress which they have since done, such opinions as these should be promulgated; but it is really astonishing, that in this enlightened country, and after the great experience we have already had of the successful application of steam to propel steam-boats, such *violent opposition* should be made to the progress of the improvements contemplated by Mr. Perkins, who, it will be recollected, brings to this country the vast knowledge he has acquired of the American superior practices: and we sincerely hope, that he will persevere in his laudable exertions, and live to enjoy as great a triumph over his opponents as Oliver Evans did over his.—Editor.

lated, that if I failed in my experiment, the credit I had acquired would be entirely lost; and, without money or credit, at my advanced age, with many heavy incumbrances, my way through life appeared dark and gloomy indeed! But I succeeded perfectly with my little engine, and preserved my credit. I could break and grind 300 bushels of plaister of Paris, or 12 tons, in twenty-four hours; and to shew its operation more fully to the public, I applied it to saw stone, in Market-street, where the driving of twelve saws in heavy frames, sawing at the rate of 100 feet of marble, in twelve hours, made a great shew, and excited much attention. I thought this was sufficient, to convince the thousands of spectators of the utility of my discovery; but I frequently heard them inquire, if the power could be applied to saw timber, as well as stone; to grind grain, propel boats, &c.; and, though I answered in the affirmative, I found they still doubted. I therefore determined to apply my engine to many new uses, and to introduce it and them to the public notice.

This experiment completely tested the correctness of my principles, agreeably to my most sanguine hopes. The power of my engine increased in a geometrical proportion, while the consumption of fuel had only an arithmetical ratio; and in such proportion, that every time I added one-fourth to the consumption of fuel, the power of the engine was doubled; and that twice the quantity of fuel required to drive one saw, would drive sixteen saws at least; for, when I drove two saws, the consumption was eight bushels of pit-coal in twelve hours; but, when twelve saws were driven, the consumption was not more than 10 *bushels: so that the more we resist the steam, the greater is the effect of the engine. On these principles very light, but powerful engines can be made, suitable for propelling boats and land-carriages, without the great incumbrance of their own weight, as mentioned in Mr. Latrobe's demonstrations.*

In the year 1804, I constructed at my works, situated a mile and a half from the water, by order of the Board of

Health of the city of Philadelphia, a machine for cleansing docks. It consisted of a large flat, or lighter, with a steam-engine of the power of five horses on board, to work machinery to raise the mud into lighters. This was a fine opportunity, to shew the public that my engine could propel both land and water carriages, and I resolved to do it. When the work was finished, I put wheels under it; and, though it was equal in weight to *two hundred barrels of flour*, and the wheels were fixed on wooden axle-trees, for this temporary purpose, in a very rough manner, and attended with great friction of course; yet, with this small engine, I transported my great burthen to the *Schuylkill* with ease; and, when it was launched into the water, I fixed a paddle-wheel at the stern, and drove it down the *Schuylkill* to the *Delaware*, and up the *Delaware* to the city; leaving all the vessels, going up, behind me at least half way; the wind being a-head.

Some *wise men* undertook to ridicule my experiment of propelling this great weight on land, because the motion was too slow to be useful. I silenced them, by answering, that I would make a carriage, to be propelled by steam, for a bet of three thousand dollars, to run upon a level road against the swiftest horse they could produce. I was then as confident as I am now, that such a velocity could be given to carriages.

Having no doubt of the great utility of steam-carriages, on good turnpike-roads, with proper arrangements for supplying them with water and fuel; and, believing that all turnpike companies were deeply interested in carrying them into operation, because they would smooth and mend the roads, instead of injuring them as the narrow wheels do; on the 26th of September, 1804, I submitted to the consideration of the Lancaster Turnpike Company, a statement of the cost and profits of a steam-carriage, to carry 100 barrels of flour, fifty miles in twenty-four hours—tending to shew, that one such steam-carriage would make more net profits, than ten waggons drawn by five horses each, on a

good turnpike-road; and offering to build such a carriage at a very low price. My address closed as follows:

"It is too much for an individual to put in operation every improvement which he may invent.

"I have no doubt, but that my engines will propel boats against the current of the *Mississippi*, and carriages on turnpike roads, with great profit. I now call upon those, whose interest it is, to carry this invention into effect."

In the year 1805, I published a work, describing the principles of my steam-engine, with directions for working it, when applied to propel boats against the current of the *Mississippi* and carriages on turnpike roads. And I am still willing to make a steam-carriage that will run fifteen miles an hour, on good level rail-ways, on condition that I have double price, if it shall run with that velocity; and nothing at all for it, if it shall not come up to that speed. What can an inventor do more, than to insure the performance of his inventions? Or, I will make the engine and apparatus at a fair price, and *warrant* its utility for the purpose of conveying heavy burthens on good turnpike roads.

I feel it just to declare, that, with Mr. *Latrobe*, I myself believed, that with the ponderous and feeble steam-engine now used in boats, they never could be made useful, in competition with sailing boats; or to ascend the *Mississippi:* believing the current of that river to be more powerful than it is. But I rejoice, that, with him, I have been mistaken; for I have lived to see boats succeed well with those engines: and I still hope to see them so completely excelled and out-run, by using my engine, as to induce the proprietors to exchange the old for the new more cheap and powerful engines.

I have been highly delighted in reading a correspondence between *John Stevens*, Esq. and the Commissioners appointed by the Legislature of New York, for fixing upon the scite of the new canal, proposed to be cut in that State. Mr. *Stevens* has taken a most comprehensive and very

ingenious view of this important subject; and his plan of rail-ways, for the carriages to run upon, removes all the difficulties that remained to be overcome. I had the pleasure also of hearing gentlemen of the keenest penetration, and of great mechanical and philosophical talents, freely give into the belief, that steam-carriages will become very useful.

Mr. *John Ellicott* (of John), proposed to make roads, of substances, such as the best turnpike roads are made with, with a path for each wheel to run on, and having a rail-way on posts in the middle, to guide the tongue of the waggon, and to prevent any other carriage from travelling upon it. Then, if the wheels were made broad, and the paths smooth, there would be very little wear. Such roads might be cheaply made; they would last a long time, and require very little repair; and they ought to be preferred in the first instance to those proposed by Mr. *Stevens*; as two ways could be made, in some parts of the country, for the same expense as one could be, with wooden rails. But either of the modes would answer the purpose; and the carriages might travel by night as well as in the day.

When we reflect upon the *obstinate opposition that has constantly been made, by a great majority, to every step towards improvement*,—from bad roads to turnpike roads —from turnpike roads to canals—and from canals to rail-ways for horse-carriages: it is too much to expect, that the prodigious leap, from bad roads to rail-ways for steam-carriages, will be made at once. One step in a generation is all that we can hope for. If the present generation shall adopt canals, the next may try the rail-ways with horses; and the third generation may use the steam-carriages.

But why may not the present generation, who have already good turnpike roads, make the experiment of using steam-carriages upon them? They will assuredly effect the movement of heavy burdens, with a slow motion of two and a half miles an hour; and, as their progress need not be interrupted, they may travel fifty or sixty

miles in the twenty-four hours. This is all that I hope to see in my time; and though I never expect to be concerned in any business, requiring the regular transportation of heavy burdens on land; because, if I am connected in the affairs of a mill, it shall be driven by steam, and be placed on some navigable water, to save land-carriage. Yet I certainly intend, as soon as I can make it convenient, to build a steam-carriage, that will run on good turnpike roads, on my own account, if no other person will engage in it; *and I verily believe, that the time will come, when carriages, propelled by steam, will be in general use, as well for the transportation of passengers, as goods; travelling at the rate of fifteen miles an hour, or 300 miles per day.!*

It appears necessary to give the reader some idea of the principles of the steam-engine which is to produce such new and singular effects; and this I will endeavour to do in as few words as I can, by shewing the extent to which the principles are already applied.

To make steam as irresistible or powerful as gunpowder, we have only to confine it, and to increase the heat, by adding fuel to the boiler. A steam-engine, with a working cylinder, only nine inches in diameter, and the stroke of the piston three feet, will exert a power sufficient to lift from 3000 to 10,000 pounds perpendicularly, two and a half miles per hour. This power, applied to propel a carriage on level roads or rail-ways, would drive a very great weight with much velocity, before the friction upon the axle-trees, or the resistance of the atmosphere, would balance it.

This is not speculative theory. The principles are now in practice, driving a saw-mill at *Manchacks* on the *Mississippi*; two at *Natchez*, one of which is capable of sawing 5000 feet of boards in twelve hours; a mill at *Pittsburgh*, able to grind twenty bushels of grain per hour; one at *Marrietta*, of equal power; one at *Lexington* (Kentucky) of the same power; one, a paper-mill, of the same power; one, of one-fourth the power, at *Pittsburgh*; one at the

same place, of 3½ times the power, for a forge, and for rolling and slitting iron; one, of the power of 24 horses, at *Middletown* (Connecticut), driving the machinery of a cloth manufactory; two at *Philadelphia*, of the power of five or six horses; and many making for different purposes: the principles applying to all cases, where power is wanted to drive machinery.

Ellicott's Mills, on the Patapsco, Nov. 13, 1815. OLIVER EVANS.

XLVIII.—*On the Blueing of Steel.**

IRON and steel articles, when their surfaces are polished, whether simply by the file or from friction with emery, putty of tin, &c. are susceptible of receiving a blue colour from the action of heat; and which is rendered more beautiful or deeper, in proportion as the surface is more perfectly polished, or the operation more carefully performed.

Every worker in iron and steel supposes himself to be capable of properly blueing the articles which he has made; but very few of them succeed well in it. There are some workmen however, who, by great experience, excel in this branch, which may be considered as an art of itself. Clock- and watch-spring manufacturers, and more particularly the makers of watch-springs, succeed very well; but the manufacturers of the steel hands for watches, have attained the highest point of perfection in it.

By means of heat, steel is made to receive a series of iris colours in the following order; viz. straw-colour, orange, red, pigeon's breast, violet, blue, and grey. Iron will receive the same colours, but is not susceptible of taking so vivid a tint as steel. When steel has been hardened, it must be tempered before it can be finished; and it must be softened more or less, according as it is necessary for the article to possess a greater or lesser degree of hardness in use. In some cases, it is not necessary to give an equal colour the whole length of the article, as the colour is frequently removed in the successive operations. It is nevertheless

* From the *Dictionnaire Technologique*.

advantageous, however, that it should be as equal as possible, in order that the degree of hardness may be uniform throughout. It is a very different case when the articles are finished and well polished, and are intended to remain blue; such for instance, as the hands of a clock or watch; as then, if the blue is not perfectly equal, and very deep, it presents a disagreeable appearance. The following method appears to us to be the most advantageous; and we have seen it practised by the workmen in Geneva and other parts of Switzerland, who excel in this art; and it has been successfully employed by many workmen in Paris. In a kind of stove made of sheet-iron, they place turfs made of tanners' bark or merely tan-dust: these are covered with lighted charcoal-dust. The fire soon communicates to the turfs or tan-dust: when these begin to burn, they place the pieces intended to be blued, upon them, taking care that the ashes do not cover them, in order that they may see the colour which they assume. It is requisite to be very careful that the heat be uniform, and that it be retained at exactly the same degree, without being too great; as, in that case the operation would fail entirely, and the blue colour soon disappear and turn to a grey; the article would lose its hardness, it must be hardened afresh, and there would be a very great chance of its being overheated. In order to avoid these inconveniences, we should prefer a fire less active, and operate by degrees. When the well-polished steel has required a red colour, and it is seen that this colour is not perfectly uniform, the greatest heat must be directed towards that part where the colour is less intense, by blowing with the mouth that part of the fire adjacent to it. By this means, and with great care and patience, a beautifully uniform and deep-blue colour is obtained.

When the article has become of a red colour, if it is found to be clouded with various shades, it is better to suspend the operation, and polish the article afresh, either with emery, tripoli, crocus-martis, putty of tin, &c. and entirely to begin anew; rather than expose the article to too great softening. We can only here point out general

rules; there exists in every art, a kind of dexterity, which practice alone can give.

When the article has acquired the desired colour, it is withdrawn from the fire, and allowed to cool slowly, when it must be wiped with a clean, dry linen cloth. Particular care is required not to touch the articles when finished, with greasy or damp fingers; but above all, not to dip them in oil, as they would become dull, and lose that lustre in which consists all their beauty. This blue colour remains for a long time: nevertheless it is subject to change; in which case, it may be restored to all its freshness, by being polished anew, and again submitted to the same operation.

Iron never takes so fine a blue as steel; as it does not receive so good a polish, neither is it so hard; and it is probable that the carbon contained in the steel, has some influence on this operation. L.

XLIX.—*Tables of Candle-light, calculated by* B. Bevan, *Esq. Civil Engineer.*

DEAR SIR, *Leighton Buzzard, Sept.* 17, 1823.

The following Tables of Candle-light may be interesting to some of your Readers. They have been verified for several years; and will be found to agree, within a minute or two, in all the Southern and Middle parts of England, in clear weather. They are expressed in *mean time;* and may be adapted to confined situations, by a few observations to determine the constant number of minutes to subtract in the evening, and add in the morning.

In cloudy weather, an allowance of 10 minutes, will, in general, be sufficient.

With the above trifling corrections, these tables will be found sufficient for all practical purposes; and, in point of usefulness, may be considered equal to the usual tables of sun-rise and sun-set, as generally published in common almanacks. Your's respectfully,

B. Bevan.

T. Gill, *Esq.*

TABLES OF CANDLE-LIGHT: Mean Time.

DAY.	OCTOBER.		NOVEMBER.		DECEMBER.	
	End Morning.	*Begin* Evening.	*End* Morning.	*Begin* Evening.	*End* Morning.	*Begin* Evening.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
1	5 .. 31	6 .. 9	6 .. 22	5 .. 6	7 .. 8	4 .. 30
2	5 .. 32	6 .. 6	6 .. 24	5 .. 4	7 .. 10	4 .. 30
3	5 .. 34	6 .. 4	6 .. 26	5 .. 2	7 .. 11	4 .. 29
4	5 .. 36	6 .. 2	6 .. 28	5 .. 0	7 .. 12	4 .. 28
5	5 .. 38	6 .. 0	6 .. 29	4 .. 59	7 .. 13	4 .. 28
6	5 .. 39	5 .. 57	6 .. 30	4 .. 58	7 .. 14	4 .. 28
7	5 .. 41	5 .. 55	6 .. 32	4 .. 56	7 .. 15	4 .. 28
8	5 .. 43	5 .. 53	6 .. 34	4 .. 54	7 .. 16	4 .. 27
9	5 .. 45	5 .. 51	6 .. 36	4 .. 52	7 .. 17	4 .. 27
10	5 .. 46	5 .. 49	6 .. 37	4 .. 51	7 .. 19	4 .. 27
11	5 .. 47	5 .. 47	6 .. 39	4 .. 49	7 .. 20	4 .. 26
12	5 .. 49	5 .. 45	6 .. 40	4 .. 48	7 .. 21	4 .. 26
13	5 .. 50	5 .. 42	6 .. 42	4 .. 47	7 .. 22	4 .. 26
14	5 .. 52	5 .. 40	6 .. 43	4 .. 46	7 .. 23	4 .. 27
15	5 .. 53	5 .. 38	6 .. 45	4 .. 45	7 .. 24	4 .. 27
16	5 .. 55	5 .. 37	6 .. 47	4 .. 43	7 .. 24	4 .. 28
17	5 .. 57	5 .. 35	6 .. 48	4 .. 42	7 .. 24	4 .. 28
18	5 .. 58	5 .. 32	6 .. 50	4 .. 41	7 .. 24	4 .. 29
19	6 .. 0	5 .. 30	6 .. 51	4 .. 40	7 .. 25	4 .. 29
20	6 .. 2	5 .. 28	6 .. 52	4 .. 40	7 .. 25	4 .. 29
21	6 .. 4	5 .. 26	6 .. 54	4 .. 38	7 .. 25	4 .. 29
22	6 .. 6	5 .. 24	6 .. 55	4 .. 37	7 .. 26	4 .. 30
23	6 .. 8	5 .. 22	6 .. 58	4 .. 36	7 .. 28	4 .. 30
24	6 .. 9	5 .. 20	6 .. 59	4 .. 35	7 .. 29	4 .. 31
25	6 .. 10	5 .. 18	7 .. 0	4 .. 34	7 .. 29	4 .. 31
26	6 .. 11	5 .. 17	7 .. 1	4 .. 33	7 .. 30	4 .. 32
27	6 .. 13	5 .. 15	7 .. 3	4 .. 33	7 .. 30	4 .. 32
28	6 .. 15	5 .. 13	7 .. 4	4 .. 32	7 .. 31	4 .. 33
29	6 .. 17	5 .. 11	7 .. 5	4 .. 31	7 .. 31	4 .. 34
30	6 .. 19	5 .. 9	7 .. 7	4 .. 31	7 .. 31	4 .. 35
31	6 .. 20	5 .. 8			7 .. 31	4 .. 36

L.—*On the Preparation and Properties of a Colourless Refined Ox-Gall, for rendering Drawings in Water-Colours more bright and permanent. By* PELTRO WILLIAM TOMKINS, *Esq. Historical Engraver to Her late Majesty Queen Charlotte.**

SIR, *St. James's Street; April* 29, 1812.

MR. TOMKINS, a friend of mine, and an eminent artist, about two years since discovered a method of freeing ox-gall from its colouring matter, a thing of great consequence to artists in all delicate colours, such as blues, purples, reds, &c. which are more or less tinged by the yellow colour in ox-gall, as generally used. Should the Society of Arts deem it worthy of attention, he will disclose the process, which is by no means an expensive one.

I am, Sir, Your most obedient Servant,

To C. TAYLOR, *M.D. &c.* THOMAS GILL.

N. B.—Samples of the colourless ox-gall accompany this, which will enable the Committee to compare it with any other preparation thereof, or *ox-gall itself*, as commonly used.

A Description of some of the Properties of the Refined Ox-Gall.

It possesses all the valuable properties of ox-gall, as applicable to painting in water-colours; with the superior advantages of being deprived of all tendency to putridity, and of all colouring matters.

It combines with, and fixes all water-colours, as they are usually prepared; either by being mixed with them, or washed over them after they are laid upon the paper, &c. It renders blue, purple, red, green, and all other delicate colours, more bright and durable; and, if a small portion of it be added to any of the colours, it causes them to

* From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. The Society voted its Gold Isis Medal to Mr. Tomkins, for this valuable discovery.

wash more freely and evenly, over the surface of the paper, ivory, &c.

Combined with gum-arabic, it gives depth of tint, without any unpleasant glossiness upon the surface of the drawing, prevents the gum from cracking, and the colours are so completely fixed in the paper itself, that subsequent tints can be washed over them, without any risk of their becoming foul, or forming improper combinations with the under colours.

Combined with fine lamp-black and gum-water, it forms a complete substitute for Indian ink.

If it be floated over the surface of drawings made with chalks, or black-lead pencil, it fixes them firmly; and they may then be washed over with any water-colours, previously mixed with a small portion of it; without, in the least degree, disturbing the chalks or black-lead.

For miniature-painting, being washed over the surface of the ivory, it completely removes its greasiness; and, being mixed with the colours, it causes them to float freely thereon; and tints may be laid over tints, the colours being struck into the ivory.

For transparencies, oiled paper being first washed over with the refined ox-gall, and permitted to dry, water-colours, mixed with some of it, will lie freely and perfectly smooth upon it; and be so fixed, as not to wash up by the repetition of different glazings of colours over each other, thus producing depth of colour.

In short, the valuable properties this refined ox-gall possesses, make it equally applicable to historical, landscape, botanical, and natural history painting, as well as to colouring prints in general; and, by it readily combining with all the vehicles used in the preparation of water-colours, and having no colour itself; it enables the artist to paint with ease, on surfaces otherwise unfavourable; at the same time rendering the colours more bright and durable.

Many other valuable properties will, no doubt, on trial,

be found in this preparation; and the result cannot fail to facilitate and improve the art of painting in water-colours: and, as the discovery of it is entirely new, it will, in all probability, be found applicable to many other useful purposes.

No. 58, *New Bond Street*, *May* 20*th*, 1812. P. W. TOMKINS.

SIR, *No.* 58, *New Bond Street*, *May* 20*th*, 1812.

Herewith I send you a certificate from Mr. Cosway and Miss Jones, in testimony of their approbation of my refined ox-gall; and likewise a farther description of its properties and uses in the art of water-colour painting; together with a sketch made in black chalk, fixed by means of it, and afterwards washed over with water-colours, also mixed with it; to shew that the chalk is so firmly fixed, as not to mingle with the water-colours in the least degree; and also a specimen, produced with a mixture of fine lamp-black and gum-water, which, combined with a portion of the refined ox-gall, becomes a complete substitute for the best Indian ink; and which you will please to add in elucidation of my former communications upon this subject to the Society. I am, Sir, your most obedient servant,

To C. TAYLOR, *M.D. Sec.* P. W. TOMKINS.

CERTIFICATES.

No. 127, *Mount Street*, *May* 19*th*, 1812.

Miss Jones presents her compliments to Mr. Tomkins, and, having made trial of his preparation for painting in water-colours, she has found it fully to possess every property he ascribes to it, in its application upon ivory, as well as paper.

Mr. Cosway has also commissioned Miss Jones to say, that he has found the result of its trial in every degree satisfactory.

To P. W. TOMKINS, *Esq. &c.*

SIR, *Charlotte Street, May 11th, 1812.*

Mr. P. Tomkins brought me, on Thursday, a specimen of clarified gall, describing it as possessing important properties, as applicable to painting in water-colours; and desiring my opinion of it, after a trial. I lost no time in making the necessary experiments; and, as the recent kindness of the Society to two of my children, had previously decided me to use every endeavour in my power to assist and promote its objects, I have preferred to send my opinion to you, for the consideration of the proper Committee. The results of three of my experiments accompany this.

Mr. Tomkins stated his clarified gall to possess the property of laying water colours perfectly smooth, on an oily or greasy surface; of considerably fixing such colours, whenever applied; and also of adding brightness, in all cases, without discolouring the purest blue and white. With a view to the first point, I gave the vehicle a severe trial, by using it with water-colour on an oiled paper; taking the mezzotint first, as is my usual practice. I found, (in No. 1,) that the quantity of gall that could be employed with so deep a tone of colour, was not sufficient to counteract the oil; but, observing in the subsequent proceedings, that the colour flowed perfectly smooth where thinly applied; and that there was no effect from the oil, wherever the colour had once passed and dried; I made the small sketch (No. 2,) on the same oiled paper, washing it over first with the gall alone. I found this to answer most perfectly, in removing the greasiness of the surface; and it also convinced me of the power of Mr. Tomkins's material, to fix water-colours; by my having been able to wash over the small lines of ropes of the vessel in front of the drawing, without in the least disturbing the colour. This last, I have regarded as an important desideratum in the use of water-colours; and it led me to make the slight sketch (No. 3,) to ascertain the other points asserted of his vehicle, by the inventor. I tried it, also, in the most difficult cases

of painting upon ivory; and, I am confident, in stating to the Society, that it possesses all the properties Mr. Tomkins attributes to it; that the discovery will confer most valuable benefits upon every painter in water-colours, who is master of his profession; and that it is highly deserving of the countenance of the Society.

I am, Sir,

Your most obedient Servant,

To C. TAYLOR, *M. D. Sec.* W. CRAIG.

SIR, *Burlington Gardens, May* 18, 1812.

Mr. Tomkins having, by desire of the gentlemen of the Committee of Polite Arts, referred to me to make trial of his refined preparation of ox-gall, I have accordingly done so; and, (allowing for the shortness of time since Mr. Tomkins applied,) I have found it greatly superior to any I have hitherto used, and fully to possess the qualities described. I remain, Sir,

Your obedient Servant,

To C. TAYLOR, *M. D. Sec.* JOHN WRIGHT.

DEAR SIR, *Hertford-Street, March* 2, 1812.

I am really ashamed I have not written before, to thank you for your present, of the preparation of ox-gall. I have used it in various ways, and find it answer expectation perfectly, as to making colours flow pleasantly on any surface of ivory, though the ivory had been long prepared.

It being so perfectly transparent, makes me conclude, that it may be used with safety with most colours; and I hope it will answer every purpose you wish, as to not injuring the effects of them, which time can only ascertain.

With sincere esteem, I remain,

Your's truly,

To Mr. TOMKINS, *&c.* GEORGE ENGLEHEART.

DEAR SIR, *Rathbone Place, March* 4, 1812.

I take the liberty of requesting, as a favour, a little more of your prepared ox-gall; I find it so extremely useful,

that I wish never to be without it. You desire to have my opinion of its qualities, as I have found them. I consider it as possessing all the properties of the gall in its original state, with this great advantage; that, by being rendered as clear as water, it does not change nor soil the colours; if any thing, it adds, I think, to their brilliancy; and the most valuable property it has, is, that of fixing the colours in the paper; and thereby preventing, in washing one tint over another, the removing of the under tint: this is an advantage, highly important and valuable. In fine, I think, that as a medium for facilitating the use of water-colours, it is a discovery which cannot be too highly valued. This, Sir, is my humble and sincere opinion of it.

I remain, Sir, Your obliged humble Servant,

JOSEPH PASTORINI.

To Mr. TOMKINS, *&c.*

Upper James Street, Golden Square,
Feb. 26, 1813.

MY DEAR SIR,

Receive my sincere thanks for your kindness, in sending me a supply of your newly discovered liquid, for painting with in water-colours, which I have used with success; and I purpose, when you make it public, to procure some for my own use, and shall recommend it to others; doubting not that my brother-artists will, (as well as myself,) find that it facilitates the execution, and adds brilliancy to the colours. Believe me, dear Sir,

Your obliged Servant,

To P. W. TOMKINS, *Esq.* P. VIOLET.

SIR,

I have made several experiments with the preparation of ox-gall, left with me by the desire of the Committee, and find it to be extremely useful; not only in it causing the colours to lie smooth on greasy paper; but in fixing colours that are apt to stir on the immediate use of the sponge; by which means we can gradually diminish their depth of tone, without losing all the force at once; or

having the green colours of trees running over the skies, and mixing with the blue, the moment they are wetted.

I am, Sir,

Your most obedient Servant,

To C. TAYLOR, *M. D. Sec.* JOHN VARLEY.

SIR,

In conformity to the wishes of the Committee of Polite Arts, I send you two phials, containing the preparation of ox-gall; likewise a sketch, made with black Italian chalk, fixed by means of it, and afterwards frequently washed over with water-colours, in which I also put a small portion of it: and another specimen, shewing, that the smoke of a common candle, caught on an earthen or glazed surface, and mixed with gum-water; and further mixed with my preparation of colourless ox-gall, becomes completely fixed in the paper; and forms so complete a substitute for Indian ink, that the difference cannot be discerned. This composition does not require grinding; it is perfectly smooth and transparent, and receives a wash of any colour over it, exactly the same as Indian ink, and cannot be washed off, without destroying the surface of the paper.

I am, Sir,

Your most obedient Servant,

To C. TAYLOR, *M. D. Sec.* P. W. TOMKINS.

Process for depriving Ox-Gall of its Tendency to Putridity; and of its Colouring Matter, so detrimental to all Delicate Colours.

To a pint of fresh ox-gall, boiled and skimmed, put one ounce of alum finely powdered; continue it on the fire until combined; when cold, put it into a bottle, and cork it moderately close.

To another pint of fresh ox-gall, also boiled and skimmed, put one ounce of common salt, and continue it on the fire until combined; when cold, put it also into another bottle, and cork it moderately close.

Gall, thus prepared, will keep perfectly free from putridity, or any offensive smell, for years.

When the above preparations have stood in a room, of a moderate temperature, for about three months, they will deposit a thick sediment, crusts will form on their surfaces, they will become clear, and be fit for use in ordinary purposes; but, as they contain a large proportion of yellow colouring matter, tingeing blue of a greenish hue, reds brown, and sullying purples; they are unfit for general use, in painting in water-colours.

Further Process.—The before-mentioned preparations, after standing until they are become perfectly clear, are to be decanted, and combined in equal proportions; a thick coagulum is instantly formed of the yellow-colouring matter, which precipitates; leaving a clear liquid, namely, the colourless ox-gall.

N. B. After the combination of the two first preparations, the process may be assisted, by filtering the liquid through paper. Age renders this preparation more brilliantly clear; and from it, it seems to obtain an agreeable scent: nor has it been observed to contract at any time an unpleasant smell, or to lose its useful properties.

P. W. TOMKINS.

LI.—*On Burnishing**.

To burnish an article is to polish it, by removing the small eminences or roughnesses upon its surface; and the instrument by which it is performed is denominated a BURNISHER. This mode of polishing is the most expeditious, and gives the greatest lustre to a polished body. It is made use of by gold and silversmiths, cutlers, locksmiths, and most of the workmen in gold, silver, copper, iron, or steel. It removes the marks left by the emery, putty of tin, or other polishing materials; and gives to the burnished articles a black lustre resembling that of looking-glass. The burnisher is an instrument, the form and construction of which

* From the *Dictionnaire Technologique.*

is extremely variable, according to the respective trades; and it must be even adapted to the various kinds of work in the same art. We shall point out the principal ones. In general, as this tool is only intended to efface inequalities, whatever substance the burnisher is made of, is of little consequence to the article burnished, provided only, that it be of a harder substance than the article.

We shall first describe the art of burnishing silver articles, and afterwards point out the variety of modes in which the burnisher is used in other arts.

When silver articles have received their last fashion from the silversmith's hands, that is to say, when they have worked, soldered, repaired, or adjusted them, they are sent to the burnisher, who has the care of finishing them. He must first begin, by cleaning off any kind of dirt which their surfaces had contracted whilst making, as this would entirely spoil the perfection of the burnishing. For this purpose, the burnisher takes pumice-stone powder, and, with a brush made very wet in strong soap-suds, he rubs rather hard the various parts of his work, even those parts which are to remain dull; and which, nevertheless, receive a beautiful white appearance. He then wipes it with an old linen cloth, and proceeds to the burnishing.

The burnishers used for this purpose are of two kinds; some of steel, others of hard stone. Steel burnishers are either curved or straight; rounded or pointed; and made so as to suit the projecting parts, or the hollows of the piece.

Stone burnishers are made of blood-stone (*hæmatite*) cut, and either rounded with the grindstone, or rubbed, so that they present at the bottom a kind of very blunt edge, or sometimes a rounded surface. These are polished with emery like steel burnishers, and are finished by being rubbed upon a leather, covered with *crocus martis*. The stone is mounted in a wooden handle, and firmly fixed by means of a copper ferrule which encircles both the stone and the wood. The best blood-stones are those which

contain the most iron, and which, when polished, present a steel colour.

The operation of burnishing is very simple: it is only requisite to take hold of the tool very near to the ferrule or the stone, and lean very hard with it, on those parts which are to be burnished, causing it to glide by a backward and forward movement, without taking it off the piece. When it is requisite that the hand should pass over a large surface at once, without losing its point of support on the work-bench, the workman, in taking hold of the burnisher, must be careful to place it just underneath his little finger. By this means, the work is done quicker, and the tool is more solidly fixed in the hand.

During the whole process, the tool must be continually moistened with black soap-suds. The water with which it is frequently wetted, causes it to glide more easily over the work, prevents it from heating, and facilitates its action. The black soap, containing more alkali than the common soap, acts with greater strength in cleansing off any greasiness which might still remain on the surface; it also more readily detaches the spots, which would spoil the beauty of the burnishing.

In consequence of the friction, the burnisher soon loses its bite, and slips over the surface of the article, as if it were oily. In order to restore its action, it must be rubbed from time to time on the leather. The leather is fixed on a piece of hard wood, with shallow furrows along it. They have generally two *leathers*—the one of sole-leather, and the other of buff-leather. The first is impregnated with a little oil and *crocus martis*, and is particularly used for the blood-stone burnishers; the other has only a little putty of tin scattered in the furrows, and is intended exclusively for rubbing steel burnishers, as they are not so hard as the blood-stones.

Blood-stone being very hard, the workman uses it whenever he can, in preference to the steel burnisher. It is therefore only in small articles, and in difficult places,

that the steel burnishers are used; and which, by their variety of form, are adapted to all kinds of work. But in general, the blood-stone greatly reduces the labour.

When the articles, on account of their minuteness or any other cause, cannot be conveniently held in the hand, they fix them in a convenient frame on the bench: but under all circumstances, the workman must be very careful to manage the burnisher, so as to leave untouched those parts of the article, which are intended to remain dull. When, in burnishing any article, which is plated or lined with silver, he perceives any place where the layer of precious metal is removed; he restores it, by silvering these places with a composition supplied by the silverer, which he applies upon it with a brush, rubbing it well, and wiping it afterwards with an old linen cloth.

The burnishing being finished, it only remains to remove the soap-suds, which still adhere to the surface of the work: this is effected by rubbing it with a piece of old linen cloth, which preserves to it all its polish, and so great a lustre, that the eye can scarcely bear to look upon it. But, when the workman has a great number of small pieces to finish, he prefers throwing them into soap-suds, and drying them afterwards with saw-dust, which is more expeditious.

The burnishers of articles which are not silver, follow nearly the same process as that above-described. We shall briefly notice the variations to be observed in each case.

The burnishing of gold or silver on wood is performed with burnishers made of wolves' or dogs' teeth, or blood-stones mounted in iron or wooden handles. When they burnish gold, applied on other metals, they dip the blood-stone burnisher into vinegar; this kind being exclusively used for that purpose. But when they burnish leaf-gold on prepared surfaces of wood, they are very careful to keep the stone or tooth perfectly dry. The burnisher used by leather-gilders is a hard polished stone, mounted in a wooden handle; this is used to sleek or smoothen the leather.

The ordinary engraver's burnisher is a blade of steel, made thin at one end, to fit into a small handle, which serves to hold it by. The part in the middle of the blade is rounded on the convex side, and is also a little curved. The rounded part must be well polished, and the tool be very hard.

They use this burnisher to give the last polish to copper-plates, rubbing them well with it, and being very careful to use oil continually, to lubricate it. Other burnishers are nearly of the same form as those used by the gilders and silverers.

In clock-making, they burnish those pieces or parts which, on account of their size or form, cannot be conveniently polished. The burnishers are of various forms and sizes; they are all made of cast-steel, very hard, and well polished: some are formed like the sage-leaf files; others, like common files: the first are used to burnish screws, and pieces of brass; the others are used for flat-pieces. The clock-makers have also very small ones of this kind, to burnish their pivots; they are called *pivot-burnishers.*

The burnishing of pewter articles is done after the work has been turned, or finished off with the scraper: the burnishers are of different kinds, some for burnishing vessels, others for pots,—these last being done by hand; they are all of steel, and while in use are rubbed with putty powder on leather, and moistened with soap-suds.

The burnishing of cutlery is executed by means of hand or vice burnishers; they are all made of fine steel, hardened and well polished. The first kind have nothing particular in their construction; but the vice burnishers are formed and mounted in a very different manner. On a long piece of wood, placed horizontally in the vice, is fixed another piece as long, but bent in the form of a bow, the concavity of which is turned downwards. These two pieces are united at one of their extremities by a pin and a hook, which allows the upper piece to move freely around

this point as a center. The burnisher is fixed in the middle of this bent piece, and it is made more or less projecting, by the greater or lesser length which is given to its base. The moveable piece of wood, at the extremity opposite to the hook, is furnished with a handle which serves the workman as a lever. This position allows the burnisher to rest with greater force against the article to be burnished, which is placed on the fixed piece of wood. They give to the burnisher either the form of the face of a round-headed hammer, well polished, to burnish those pieces which are plain or convex; or the form of two cones, opposed at their summits, with their bases rounded, to burnish those pieces which are concave or ring-shaped.

The burnishing of the edges of books is performed with a wolf's or dog's tooth, or a steel burnisher: for this purpose they place the books in a screw press, with boards on each side of them, and other boards distributed between each volume; they first rub the edges well with the tooth, to give them a lustre. After the sprinkling has been done, and the edges are become dry, they begin to burnish the gutter; then turning the press, they burnish the edges at the top and bottom of the volume.

They burnish the edges in the same manner, after having applied the gold; but they observe, in gilding, to lay the gold first upon the gutter, and allow it to dry; and, on no account, to commence burnishing till it is quite dry.

LII.—*On Encouraging an extended Growth of Potatoes; on the Manufacture of Farina or Flour from them; and on applying it to make Sea Biscuits, Bread, Pastry, &c. By* JOHN WHATELY, *Esq.**

SIR, *Cork, April 19th*, 1823.

IT is naturally the first object, and forms the chief duty of a well-regulated state, to provide its members with

* From Vol. XXXI of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. The Society voted its Lesser Gold Medal to Mr. Whately, for this valuable Communication.

a sufficient quantity of good food. The greater are the advantages, and the more independent is the situation of that country, which can furnish within itself, an ample supply of the means of subsistence to its inhabitants. We have long ceased in this country, to feel the benefits arising from such a state of independence; and we have during the last ten or fifteen years, incurred a very large expenditure in the purchase of foreign corn. This subject has engaged much of my attention, and I have endeavoured to devise a plan, by which the agriculture of this country may be improved, a great expenditure saved, and a considerable reduction of prices effected,—by the introduction into bread, of an article of known nutritious properties, derived from the potatoe. This substance is the farina, or flour of that valuable root, which I have tried, with advantage, to a very great extent; having previously gone through a long course of experiments on making bread, biscuit, and pastry; from mixtures of raw potatoes, boiled potatoes, and farina, with different proportions of flour, &c.

It is well known, that poor light soils, unfit for the culture of wheat, and from which only crops of barley or oats have been produced, and of which, in many situations, there are large tracts of land altogether uncultivated, will produce potatoes of excellent quality. Two circumstances have, however, hitherto prevented their culture, to the desirable extent; namely, the great expense of their carriage, in a raw state, from the interior parts of the country, to a proper market; and their not keeping well, more than six months after the crop is gathered.

These inconveniences I have obviated, by the invention of a machine, which is now in the Society's house; by which one person can grind down fifteen hundred weight, or seventeen hundred pounds nett, of potatoes, into a soft pulp, in one day; yielding about two hundred weight of farina or flour, when dried.

By calculation, the power of a single horse will be equal to the grinding of twenty-two tons of potatoes per week;

the machine is capable of being applied to any power, or first mover, required. *The farina, or flour, has been known to keep good seventeen years; and it may be afforded, so as to yield a fair profit to the farmer and the manufacturer at threepence per pound.* The present price of wheaten flour, is about five pence farthing.

It would be tedious to enter into a long detail of this business by letter; but my Son is now in London; and, if he is permitted to attend a Committee of the Society, and to give proofs of the trials I have made, by exhibiting specimens of the bread, flour, and biscuits; and by furnishing such other particulars as may be required. I trust they will perceive the great benefits that may result from this article; and, particularly, if my communications should merit the sanction of the Society, and be honoured with its approbation. I remain, Sir,

Your most obedient humble Servant,

To C. Taylor, *M.D. &c.* JOHN WHATELY.

Remarks from Mr. Whately, jun. on Potatoes.

It may not be generally known, but it is capable of the most satisfactory proof, that *the same quantity of land will yield above one-half more of farina, or flour, where potatoes are cultivated, than if the same land was applied to the production of flour from wheat.*

I have proved, from experiment, that 2619 pounds of pure farina, or flour, may be produced from an acre of land, planted with potatoes; and only 1660 pounds of flour from an acre of wheat. It will, therefore, be obvious, that, if we can apply this great excess to the same purposes as the flour of wheat, the advantages arising from it will be of the highest importance to the community. We now require from foreign countries about 500,000 quarters of wheat annually; for which we incur an expenditure of about two millions sterling, in ordinary years; and which has increased, in years of scarcity, to upwards of seven

millions sterling; and there seems no probability, that, under the continuance of the present system of cultivation, we shall ever arrive at the period when we can supply our own wants, and feel independent of foreign aid, for one of the first articles of subsistence.

We have had, for the last ten years, not only a course of favourable seasons, but the farmer has had, in the greater part of that period, the benefit of high prices, to stimulate his exertions to the greatest possible production of corn; and, if they have failed, under such favourable circumstances, to satisfy our wants, what evil may we not expect, if the seasons should prove unpropitious, and the inconveniences of our situation be aggravated by scarcity? I admit that the prospect of supplies from foreign countries may be great; but we should recollect, that only a few months have elapsed since the ports of Europe and America were shut against us; or only open, under a system of license: and that it is a situation of dependence, which no well-wisher to his country can be desirous to see recur, nor the possibility of which he will not feel anxious to prevent.

[*To be continued.*]

LII.—*On recovering Gold or Silver from old Gilt or Silvered Wood, &c.**

UNTIL very lately, the small quantities of gold or silver that could be procured from the surfaces of wood, &c. which had been gilt or silvered, was not thought worth the trouble of taking off; and this wood was burnt the same as any other fire-wood, without even searching in the ashes for the gold or silver they contained. Persons, who were aware of its value, bought this sort of wood at a very cheap rate, and burnt it by itself, on their hearths; and after-

* From the *Dictionnaire Technologique.*

wards, with great trouble, collected from among the ashes, all the gold &c. they contained, by the process of amalgamation. This was difficult and troublesome, on account of the vast quantity of ashes produced by the wood; and in consequence of the thick coating of carbonate of lime, with which it had been covered; and this process was by no means economical.

The following simple means may be employed with profit.—First, steep the wood in boiling water, and for this purpose, a trough must be made, capable of receiving the longest pieces, and sufficiently wide to contain a number of them; then pour on the wood a quantity of boiling water sufficient to cover it, and cover the trough with a lid, which closes it as perfectly as possible, in order to retain the steam of the boiling water, as well as to keep it hot for a long time. The operation is however performed better, and in less time, by means of the steam of boiling water, which may be introduced into the close vessel containing the gilded wood; and to which a safety-valve is applied; or, perhaps still better, by putting it into a boiler of the form of the trough we have described, and setting it upon the fire. The boiling water or steam dissolves the glue or size which secured the leaf-gold; which, on being detached falls into the water. In order to accelerate the separation of the leaves of gold, they take out the pieces of gilt wood, after they have been steeping for some time in the boiling water; they then put them into another vessel, containing a little hot water, and, with a brush wetted in this water, they brush over the gold, which easily separates and remains in the water; into which they are also careful frequently to dip the brush. The coat of size and whiting remains almost entire on the wood; and a part of the gold size only is removed with the gold, and is found mixed with it in the water.

They allow the water to remain at rest; and when the whole is precipitated, they decant the water, and evaporate the deposit to dryness. They then remove the matter

found at the bottom of the vessel, powder it in a mortar, and expose it to the action of fire under a muffle, in order to burn all the glue and the greasy or oily substances which formed a part of the coating. The gold is then separated from it by amalgamation.

This process is also applicable to old gilt plaster; and whether it be taken off the wall, or remain upon it. In the latter case, the gilded part must be washed with hot water and a sponge, and be thoroughly cleaned off with a hard brush, frequently dipped in the hot water. But we must by no means neglect to collect together the mortar, &c. which falls off from the walls so treated; as it generally contains a great quantity of gold, which it is important to unite in the *washings*. By this means, we have known to be recovered more than 800 franks' worth of gold, from an old chapel which was repaired.

The same process, which is made use of to recover the gold from gilded wood or plaster, is also equally applicable to the removing of any silvering which had been laid on with silver leaves. This, although less lucrative than that of recovering gold, must nevertheless not be neglected, as it produces very good results, when it is performed with dexterity and economy.

The gold and silver also from gold and silver lace, spun upon silk, when it is become old, may be burnt for the purpose of collecting the gold and silver. For this purpose it is made up into packets, like balls, wrapped round with iron wire, and made red-hot in a furnace; by this means the silk is reduced to ashes. When the packet is cold, they beat it in a mortar or kind of tray: the ashes all become powder, which they place upon a pasteboard, and fan or blow it gently, when the metallic parts, being the heaviest, remain, and the ashes are carried away by the wind. We must not, however, conceal the fact, that by this means, a little gold or silver will be lost; unless the ashes blown off be washed over afterwards.

There is, however, an easy means of preserving the whole

of the valuable parts, if the operation is carefully performed. The lace or stuff must be cut into very small pieces, and be boiled for some time in soap-boilers' caustic lees (pot-ash, or caustic soda): these substances dissolve the silk; and the gold or silver remain pure in the liquor. The alkali must be washed off, and the deposit be afterwards treated by the *depart*, in order to separate the gold and silver. L.

LIV.—MISCELLANEOUS.

THE ANNUAL COURSE of LECTURES and MEDICAL INSTRUCTION, at *Guy's* and St. *Thomas's Hospitals*, will commence early in the present Month of OCTOBER; and the following are the arrangements for the Season.

Separate Courses of Lectures on the Theory and Practice of Medicine, Pathology, Therapeutics, and Materia Medica, will be delivered by Drs. Cholmeley and Back, Physicians to Guy's Hospital.

On the Principles and Practice of Chemistry; by William Allen, Esq. F.R.S. Dr. Bostock, F.R.S. and Arthur Aikin, Esq.

On Experimental Philosophy; by William Allen, Esq. F.R.S. and John Millington, Esq. Professor of Mechanical Philosophy, Royal Institution.—To commence on the 4th of November.

On Midwifery, and the Diseases of Women and Children; and on Physiology, or the Laws of Animal Economy, by Dr. Blundell.

On the Principles and Practice of Surgery; by Sir Astley Cooper, Bart. To commence on the 1st instant.

On Anatomy and the Operations of Surgery, by Sir Astley Cooper and Mr. Green.

On the Structure and Diseases of the Teeth; by Thomas Bell, Esq.

On Medical and Practical Botany; by Dr. Bright, Assistant Physician to Guy's Hospital.

A Course of Chemical Lectures will be delivered in the Course of the Season.

Particulars may be had (gratis) of Mr. Stocker, Apothecary to Guy's Hospital; who enters Pupils to all the above Lectures.

An Important Improvement in Tanning.

A MOST material improvement has been made in tanning, by Gybbon Spilsbury, Esq. of Walsall, in Staffordshire, which promises to make an entire change in the methods now employed. By the application of some known principles, *Mr. Spilsbury has succeeded in perfectly tanning the thickest hides in less than a fortnight, and skins, in four-and-twenty hours only.* We understand that no difference is made in the materials employed; but, simply, in their application.

We have seen some of the leather produced by Mr. Spilsbury, in his early experiments, which was well tanned throughout; and have reason to believe, that it will, in every respect, wear better than leather as commonly tanned. The invention has been secured by Patents for the three Kingdoms.

Mr. Badnall's Improvements in Silk-Throwing.

IT was our wish, in our present Number, to have laid before the Public the specification of Mr. Badnall's Patent for Improvements in Silk-Throwing, which we have already briefly noticed; but it becoming due so late in the month, has rendered it impossible to complete the necessary engravings in time. We hope however, in our next Number, to enter fully into the subject. In the mean time, we feel confidence in recommending these inventions to the public notice; not alone from the conviction we entertain of their utility and importance, from having been eye-witnesses of their effects, but from the fact, that they are

now working upon an extensive scale with success. The saving effected, we cannot exactly say; nor indeed is it possible to state it, unless comparatively, so much depending upon the size of the silk worked by it: but one thing is certain, that every operation in the manufacture of Organzine, Sewings, Tram, &c. except that of winding, is accomplished at once, thereby saving room, machinery, and labour.

Improved Copper-Sheathing for Ships.

Mr. Mushet, of his Majesty's Mint, has lately obtained a Patent for an improved mode of manufacturing copper for the sheathing of ships, and other useful purposes*. In a naval and commercial country like this, any improvement in the coppering of vessels must be a matter of great consequence. We understand, that, in the navy and merchant service, the copper-sheathing of a ship does not, upon an average, last more than four years—it is then found to have lost from thirty to forty per cent. of its weight, and the ship must be sent to dock, and new coppered. A remedy for this great expense, loss of time, and capital, we understand is likely to result from Mr. Mushet's invention; for that gentleman calculates, that copper may be so prepared as to last upon a ship's bottom from ten to fifteen years; or, indeed, that the timbers of a ship may want repair, before the copper is, in any great degree, injured by wear.

LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal, since Aug. 21, 1823.

To Benjamin Rotch, of Furnival's Inn, in the City of London, Esq.; for an improved Fid for the upper Masts of Ships, and other Vessels. Dated Aug. 21, 1823.—To be specified in six months.

To James Surrey, of Battersea, in the county of Surrey, Miller; for a new method of applying heat for the pro-

* See p. 104, of our present Volume.

ducing Steam, and for various other purposes, whereby the expense of Fuel will be lessened. Dated Sept. 4, 1823. —In two months.

To William Woodman, of York Barracks, Veterinary Surgeon, of the 2d Dragoon Guards; for an improved Horse-Shoe, which he denominates The Bevelled-Heeled Expanding Shoe. Dated Sept. 11, 1823.—In two months.

To Bryan Donkin, of Great Surrey Street, in the county of Surrey, Engineer; for a means or process of destroying or removing the fibres from the Thread, whether of Flax, Cotton, Silk, or any other fibrous substance, composing the fabrics usually termed Lace Net; or any other denomination of Fabric where holes or interstices are formed by such threads, in any of the aforesaid fabrics. Dated Sept. 11, 1823.—In two months.

To John Hughes, of Barking, in the county of Essex, Slopseller; for a certain means of Securing the Bodies of the Dead in Coffins. Dated Sept. 11, 1823.—In two months.

To Henry Constantine Jennings, of Devonshire Street, in the Parish of St. Mary-le-Bone, in the county of Middlesex, Esq.; for an Instrument to be affixed to the Saddle-tree, by the application and use of which, inconvenience and distress to the Horse may be avoided. Dated Sept. 11, 1823. —In six months.

To James Sprigg the Elder, of Birmingham, in the county of Warwick, Fender Maker; for a certain improvement in the manufacture of Grates, Fenders, and Fire-Iron Rests. Dated Sept. 11, 1823.—In two months.

To Thomas Wickham, of the Town of Nottingham, Lace Manufacturer; for an improved and prepared Rice; rendered applicable for use, in all cases in which starch is applied. Dated Sept. 11, 1823.—In six months.

To William Hase, of Saxthorpe, in the county of Norfolk, Ironfounder; for a new method of constructing Mills or Machines, chiefly applicable to Prison Discipline. Dated Sept. 11, 1823.—In two months.

THE

TECHNICAL REPOSITORY.

LV. — *Specification of the Patent granted to* RICHARD BADNALL, *the Younger, of Leek, in the County of Stafford, Silk Manufacturer; for certain Improvements in the Throwing, Twisting, or Spinning of Sewing Silks, Organzine, Bergam, and such other descriptions of Silk, as the said Improvements may be applicable to.—Dated March* 18, 1823.

WITH A PLATE.

I, the said Richard Badnall, do hereby declare, that the nature of my said Invention, and the manner in which the same is to be performed, are particularly described and ascertained, in and by the Drawing hereunto annexed, and the following description thereof; that is to say:

In the drawing, see Plate XI., A A, fig. 1, is one of the main spindles of a machine for throwing, twisting, or spinning of sewing silks, Organzine, Bergam, and such other descriptions of silk as the said improvements may be applicable to; this spindle turns in a hole or step, placed in the upper end of the screw, B, which screws into a female screw let into the rail, C, and in a gap or notch, D, in the rail, E, of the machine frame, and is prevented from coming out of the gap by the pin F. This spindle is driven by a strap or band, G, coming from a band-wheel or drum, acting upon the whorl H: upon this spindle are affixed the cross-pieces I and J, which are cleft, and united by screws, so as to embrace and be firmly attached to the spindle; at each end of the cross-piece J are holes or steps, K K, in which, and in the pivot-holes, L L, the two

secondary spindles, MM, revolve; upon each of these spindles a toothed wheel, NN, is affixed, which acts within a fixed toothed ring, OO, formed in a metal plate, PP, which is secured by screws to the rails, QQ, but can be occasionally disengaged from the toothed ring, OO, as will be described hereafter; these secondary spindles, MM, are made taper, so as to hold the bobbins, RR, firmly upon them.—SS are wire guiders, with an eye at each end of them; these guiders play loosely upon the spindles, MM, and are prevented from coming off by the nuts, TT.—Upon the top of the main spindle is screwed a brass cap, U, into which are likewise screwed the two lower wire guiders, VV, and the two upper ones, WW. The main spindle, AA, being turned by the strap, G, the fixed ring of teeth, OO, causes the two toothed-wheels, NN, upon the secondary spindles, to revolve in the contrary direction to the main spindle, which secondary spindles twist or spin the silk, which is led through the eyes, R, T, V, and W; before, however, passing through the eyes, WW, the two threads are crossed once around each other, so as to be confined perpendicularly over the top of the main spindle; and, after passing through the fixed eye, X, are twisted together by the action of the main spindle, and are drawn upon a reel, in the usual manner of silk-throwing.—In case one of the threads should break, in order to prevent single threads from being reeled, a knife, Y, is fixed to the rail Z; and the unbroken thread flying outwardly, on being disengaged from the other, is instantly cut by the knife. Care should, however, be taken, to place the knife at a sufficient distance from the point of crossing, to prevent the possibility of the threads being cut, whilst unbroken; and which, from the centrifugal action, might otherwise take place. On the thread being thus broken and cut, the person attending the mill can immediately stop the movement of the main spindle, by pushing in the bolt, *a*, which catches against the lower cross-bar, J.

Fig. 2, is a plan, taken below the bobbins, R R, in fig. 1, shewing the ring of teeth, O O, in the plate, P P, the cross-piece, I, and the two pivot-holes, L L, in which the secondary spindles turn, carrying the toothed-wheels N N upon them.

Fig. 3, is a plan of the cap, U, the wire guiders, V V, and W W, and the knife, Y, fixed upon the rail Z.

I have thus described the action of this machine, as applicable to the manufacture of Organzine. But as it is a matter of considerable importance, that the article known by the name of Tram, should be also manufactured by the same machinery, I shall proceed to shew how this is to be effected; and, in the first place, as it is necessary to stop the revolution of the secondary spindles, M M, so I have provided a bolt, *b*, which, on being pressed downwards, rests between the teeth of the two wheels, N N, and is secured there, by tightening the screw, *c*.—The wheels N N are then to be raised out of contact with the ring of teeth, O O, by turning the screw, B; and, in order to admit of this, the upper neck of the spindle, A A, is elongated. When it is requisite to throw Bergam, one of the toothed wheels, N N, must be taken from its spindle, and the other be allowed to act in the ring of teeth, O O: this, however, is unlikely to be wanted, where Organzine can be obtained at the same expense and trouble.

Fig. 4, shews another method of arranging the eyes, V V and W W, upon the main spindle, A A; through which the two pieces of wire, V V and W W, may either be passed and secured; or, otherwise, they may be screwed on, as shewn in fig. 4.—If due care be taken that the eyes, V V and W W, be placed as nearly as possible over the centre of each bobbin, the eyes, T T, in fig. 1, may be then dispensed with.

Fig. 5, shews another method of giving a rotary movement to the wheels, N N, upon the secondary spindles; in which case, these wheels, having plain cylindrical surfaces, act against the spring, *d*, *d*; which, during their revolution,

presses upon them, by its inward tendency: this spring is fastened at one end, in a hole, made within the circular plate, PP, and its loose end is so arranged, as to suit the direction in which the main spindle is required to revolve. In winding the silk upon the bobbins, RR, of fig. 1, I should recommend the guider, commonly used in doubling frames; which can be varied in the extent of its horizontal movement, as the winder may find necessary. This is done to prevent the silk from collecting upon the edges of the bobbin, which, otherwise, frequently happens; and, for this purpose, would be found troublesome, the bobbin being made smaller in diameter in its middle, than those in common use. For throwing sewing silks, the secondary spindles requiring, in general, a nearer proportion to the revolutions of the main spindle, than can be the case, when moving within the ring of teeth, OO, or the spring, *d*, *d*; I have provided a new arrangement, shewn in fig. 6, where any required proportion of twist, between the main and secondary spindles, can be obtained, by altering the sizes of the wheels *ee*, or the wheel upon the main spindle; thereby rendering this principle applicable to almost, if not every purpose of silk-throwing. In this figure, the lower ends of the spindles, *ff*, turn in steps or holes, *gg*, made in the rail *h*, and their necks in collars, affixed in the rail *i*; upon these spindles, which are tapered, like the secondary spindles before described, are affixed the bobbins, *jj*; and they are also furnished with guiders, *kk*, and nuts, *ll*, as usual. The lower end of another spindle, *m*, which I call my main spindle, runs in a step or hole, *n*, made in the upper end of the screw, *o*, and its neck turns in a collar in the rail *p*; upon the last spindle is affixed a wheel, *q*, the size of which regulates the throw. Upon the lower end of the main spindle a whorl, *r*, is affixed, which receives motion from a strap, *s*, driven by a drum or band-wheel. This main spindle, *m*, when revolving, communicates contrary movements to the secondary spindles, *ff*, by its wheel, *q*, acting in the wheels, *ee*, upon them.—The

silk from each of the bobbins, *jj*, being twisted by this operation, is drawn through the eyes, *tt*, and *u*, by the action of the metal grooved roller, *v*, and the upper covered roller, *w*; motion being communicated to the roller *v*, from the moving power; and the roller *w*, being pressed down upon it, by an adequate weight or spring, the silk is drawn up, as before mentioned; but care must be taken, that the speed of the rollers is proportionate to the degree of twist required. The silk, after passing through the rollers, *v*, *w*, is twisted by the fly, *x*, which, after the manner of cotton-spinning, is affixed to the main spindle, *mm*; and is gathered upon the bobbin, *y*, as in cotton-spinning. Underneath the bobbin, *y*, which plays loose upon the spindle, *m*, is placed a piece of leather, *z*; which, together with the bobbin, *y*, rests upon the lever, 1; and which lever is raised and depressed, either by a heart-wheel, or by a crank and rod, 2, affixed to a toothed-wheel, 3, actuated by a pinion, 4, on the axis of the roller, *v*, as there shewn; or by any other suitable movement.—The object of this lever is, to raise and lower, alternately, the bobbin, *y*, so as to cause an equal distribution of the silk upon it. In case of necessity, and where the lightness of the bobbin requires it, the spring, 5, will be found useful, in regulating its drawing power.

Should Tram be required to be thrown on this machine, by screwing up the step, *n*, the toothed wheel, *q*, is raised above the secondary wheels, *ee*, and prevents the revolutions they would otherwise have.

Fig. 7, shews the relative positions of the wheels, *ee*, and *q*; but, according to convenience, they might be placed in any other position, where their action would be similar.

I have thus described the various parts of the machines, and the methods of applying them in use. I do not, however, mean or intend thereby, to limit myself to those methods only, but to avail myself of every means by which my said Improvements can be carried into effect; neither do I intend hereby to claim as my inventions, each particular part, of which these machines may be composed; al-

though I do their general arrangement: nor, as in figures 1, 2, and 5, the revolution of two secondary spindles around a main one, however actuated, whether by being placed within a circle, or by any other method, producing the same effect, which I have, in different places, seen accomplished in various ways; but, having overcome the main difficulty, which, I conceive, has hitherto been an obstacle to the perfection of such methods, by my Invention of preventing single threads being reeled, by crossing and cutting them; I do hereby claim that particular method.

The general arrangement, too, of figures 6 and 7, I claim as a new combination of machinery; and, in particular, the actuating of the spindles, *ff*, and *m*, by wheels, whether toothed or plain; which prevents the possibility of irregular movements; and, by giving an unlimited power of varying their proportions, renders them applicable to almost every description of silk-throwing.

OBSERVATIONS BY THE PATENTEE.

The principal advantages of the Improvements in Silk Throwing, under this Patent, are—

1st.—That the spinning, doubling, throwing, and reeling of the silk, are accomplished by one operation.

2d.—That the machinery effecting the above, occupies no greater space than that generally used in silk throwing, thereby saving the doubling-frame, and one of the throwing-mills.

3d.—That the possibility of single threads being reeled is prevented.

4th.—That the machinery for throwing organzine, and sewing silk, is also applicable to the throwing of tram, thereby saving the doubling, as well as possessing the advantage of throwing any description of silk, by the same machinery.

5th.—That independently of several other advantages, the great saving of room and machinery, and the conse-

quent extent of business, capable of being carried on with a much smaller portion of capital than now requisite, present the most important advantages to all persons about to erect new factories.

LVI.—*Specification of the Patent granted to* ROBERT JOHN TYERS, *of Piccadilly, in the County of Middlesex, Fruiterer; for a Machine or Apparatus to be attached to Boots, Shoes, or other covering of the Feet, for the purposes of Travelling or Pleasure.—Dated April 22,* 1823.

WITH A PLATE.

I, the said Robert John Tyers, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained, in and by the Drawing hereunto annexed, and the following description thereof; that is to say:

My said apparatus consist of, what I term, my *Volitos*, or substitutes for the skates ordinarily used upon the ice; these being mounted upon wheels, and are therefore capable of being used upon land, in a similar manner to skates upon the ice, to perform the various evolutions and movements peculiar to the art of skating.

For this purpose, it is requisite, that only a single line of wheels should be affixed to each Volito, and that in the centre of it; and also, that the middle wheel should be rather larger, or greater in diameter, than those on each side of it; and that the adjoining ones, again, should be rather larger than the next to them, and so on to each extremity of the Volito; or that, in case of the wheels being all nearly of the same size, they must be so placed, as that their lower parts, or edges, may all touch a line, which may be a portion of a circle; and also, that one wheel in each should be placed under, or nearly under, the heel of the person using them. In order, however, to explain more fully the nature and construction of my said invention, I shall refer to the Drawing, which, as aforesaid, accompanies

this my said specification; and in which Drawing, (see Plate XII,) A A, &c., in figs. 1, 2, 3, 4, 5, 6, and 7, is the stock, or wooden part of the Volito: B B, &c., in figs. 2, 3, and 4, a frame, made of iron, steel, brass, or other proper metal; and which is secured or affixed to the stock, A A, by means of the screws, C C, &c. On each side of this frame, B B, &c., are formed ears, D D, &c., with holes in them; viz., a square hole in each ear, along one side of the frame; and round holes in those of the other side: these holes are intended to receive the screwed pins, E, E, &c. (one of which is shewn separately in fig. 9), which are secured in the holes of the frame by the screwed nuts, F F, &c. (one of which is shewn separately in fig. 10). Upon these pins, the wheels, G G, &c., turn; and which said wheels may be made of brass, cast-iron, or other proper metal or material: their rims are rounded, as shewn in the different figures; or the wheels may have fixed necks or pivots in them, to turn in holes made in the sides of the frame; but, in this case, one of the sides must be made to take off, to put in or take out the wheels.—H, in figs. 1, 2, and 3, is a stop; which may either be made to form part of the frame, B B, or be removeable at pleasure; as may be, also, the nose, or turned up part, I, at the opposite end of the Volito.—J, in figs. 1 and 2, is a spike, to enter the heel of the boot or shoe of the wearer of the Volito; and K K, &c., are other smaller spikes, to secure the sole steadily, when the stock is buckled, or strapped tight upon the foot, in the same manner as skates are usually fastened. It should be observed, that fig. 4, is a section of the Volito, taken at the dotted line, L L, in figs. 2 and 3.—Figs. 5, 6, and 7, represent another method of constructing the Volito, differing from the preceding, chiefly, in the holes for the pins being made in the sides of the frame, B B, instead of in the ears. In these figures, the same letters of reference indicating the similar parts, it is unnecessary again to particularize them, but only to point out differences in the construction; and,

first, that, instead of the stop, H, of figs. 1, 2, and 3, another wheel, G, is introduced at that end of the Volito; and the nose, I, is omitted. In case, however, it should be wished to introduce a stop, the wheel, G, is made to take out; and the cylinder, M, fig. 8, is fixed between holes made on purpose; and the stop, N, figs. 11 and 12, is placed in the frame, B B, and secured by screwed pins and nuts, E and F, in the same manner as the wheels, G G, &c., were, as before described. The Volitos above described are intended to be used upon hard, smooth, and level stone or brick pavements, oak floors, or other similar surfaces; and upon them all the movements common to the art of skating upon the ice may be executed. When, however, the Volitos are intended to be used for the purposes of travelling upon hard and smooth gravelled foot-paths, the wheels should be made as broad as the frames will permit; and sometimes it may even be necessary to employ wider frames, in order to receive still broader wheels. The wheels may also have grooves made in the middle of them, so as to afford a broader bearing, useful to learners of the art of skating; but not so eligible in performing the various evolutions, as they require, as in skates, only a single line of bearing.

I have thus given some examples of methods of carrying my said Invention into effect; not that I mean or intend thereby to limit myself to the employment of those methods only; but, on the contrary, I hereby claim every mode in which my said Invention, of applying a single line of wheels to my Volitos, in place of the ordinary irons of skates, can be carried into effect.

LVII.—*On the Formation of the New Mechanics' Institution for the Promotion of Art and Science.*

This new Institution is the result of what, *prima facie*, would appear an evil; viz., a quarrel with, and a consequent secession from, another most useful society, called the Andersonian Institution, by the bulk of a class of 600 indivi-

duals. The consequence of this quarrel and secession will be—Glasgow enjoying two institutions instead of one—the labours of half-a-dozen lecturers instead of two or three—and an increased energy in the now rival managers of both. Upon these grounds we are highly delighted with the probable increase of the means of improvement, although we should be grieved that the causes of that increase may be hurtful to the feelings of all or any of the talented and philanthropic men connected with the other institution. The following is the way in which the seceders state their case:

"In the year 1800, Dr. Birkbeck, then Professor in Anderson's Institution, projected and commenced a series of lectures for the instruction of the mechanics of Glasgow, in some of the most useful branches of Mechanical Philosophy and Chemistry. That eminent Philanthropist delivered these instructions *gratuitously*, to crowded classes, for two sessions. A trifling fee, to cover incidental expenses, but of which Dr. Birkbeck had no share, was afterwards levied, at the request of the Members of the class. Upon the appointment of Dr. Ure, the present Professor, who succeeded Dr. Birkbeck in 1804, the Session was extended to twenty-four weekly lectures, and the fee fixed at ten shillings—yielding, for many years, upwards of 200*l.*, and forming the chief source of revenue which the Professor derived from his situation. In the year 1808, there was attached to the class a small Library, collected by voluntary donations from friends to the mechanics, and supported by certain fines submitted to by the readers. For many years this class continued to be well attended, and it is admitted to have been productive of considerable benefit. More recently, however, especially for several years previous to the Session of 1822-3, the attendance gradually diminished, arising from the apathy and neglect which were shewn to the interests and welfare of the Class by the Managers of the Institution, and from the narrow and imperfect views of the subject which could possibly be developed in twenty-four lectures only. At the commence-

ment of each new Session, the attendance was generally respectable, but it was reduced almost one-half before the close of the course; this fact, while it proves the continued and anxious desire of the mechanics to avail themselves of the opportunity of obtaining instruction, exposes the very unsatisfactory and discouraging nature of the course prepared for them. The benefits of such a Class, not merely to mechanics, but to society at large, which had been anticipated by its distinguished founder, and which had hitherto been in some measure realized, it was justly feared would, under these circumstances, be soon lost to the artisans of Glasgow.

"In the winter of 1821-2, several friends of the Class made an attempt to renovate the establishment. An active and zealous committee was named by the Class to superintend its interests. The gentlemen thus named, found, on inquiry, that the Class had been so much neglected, that no regulations existed for its management; or, if they ever existed, that they were, from unknown causes, no where to be found. Under these circumstances, they entered into a negotiation with the Managers of Anderson's Institution, and, after much exertion, concluded a final arrangement, in which various judicious regulations were established, which they conceived would place the Class on a sure and lasting footing of independence and consequent prosperity. That the mechanics, at least, thought so, the succeeding session abundantly proved. So great were the effects of the new arrangement, that no sooner were the arrangements made public, than the Class — which, for several years previously, averaged only about 300—commenced the Session of 1822-3 with nearly 600 students, and the hall was even found deficient in accommodation for the additional crowds of mechanics who applied for tickets. The new arrangements having been thus duly appreciated by those for whose immediate benefit they were made, it was to be expected that, so far as the Managers were concerned, they would be by them also persevered in, since

they were evidently equally advantageous to the interests of Anderson's Institution and its Professor, and to the Members of the Mechanics' Class. During the Session, however, the Committee had frequent occasion to discover that the arrangements and regulations, which they had considered as finally concluded at the commencement of the course—and which had, therefore, been obtained from the Secretary of the Managers, read to, and approved of by the Class, in presence of the President, and several of the Managers of the Institution—were, in some of their most important, and in their fundamental provisions, not meant to be observed, but, on the contrary, were declared by the Managers as not sanctioned, and such as never would be sanctioned. This appalling discovery, and certain other censurable circumstances connected with the mode of tuition, created a diminution, in the latter part of the course, of no less than about 200 students.

"It is unnecessary to detail the whole minor subjects of difference between the Managers of the Institution, and the Committee of the Class. It will be sufficient to state the principal question, which, indeed, involved the very existence of the Class, and was that on which the members felt compelled to separate themselves from the Institution. The mode in which the Library was commenced and carried on, has been already mentioned. Under a part of the admitted arrangement of 1822, a fund, arising from two shillings off each ticket, was provided for the extension of the Library, and for establishing and preserving a Museum of Mechanical Models and Philosophical Apparatus, either presented by members, or purchased with funds belonging to the Class. It was now expected that the mechanics and their friends would be induced to make still larger donations of property to the Class; and it was further expected that the ingenious artisan would find a stimulus to apply the lessons of the Lecturer, and the fruits of his reading, to the construction of models, which would stand in the Museum, with the maker and donor's name affixed. To

secure all this, however, it was evident that the Managers must clearly have expressed, that the property thus acquired was the sole property of the Class, and subject alone to its management. No part of the funds of the Institution was to be appropriated to the support of the Mechanics' Library and projected Museum. All the books, and the models and machinery for the Museum, were to be purchased out of the funds, or presented as donations from members of the Class. To whom, then, in common justice, did this property belong, but to the Class? All that it asked of the Managers was to declare that the property, thus acquired, and belonging to the Mechanics' Class, should not be identified with the property of the Institution, nor subject to its fate; and that, in the event of the lectures to the Mechanics' Class being discontinued, the Library and Museum should be open to the mechanics of Glasgow in general, upon payment of a small sum annually. This just and reasonable declaration the Class determined should be an indispensable condition in the arrangement under which they would consent to remain in connexion with the Institution; and this they conceived to be the more necessary, since, by the will of Professor Anderson, in which the establishment of a class for mechanics forms no part, no books nor apparatus were to be permitted to be sent out of the Institution buildings. To this condition, however, the Managers most pertinaciously and decidedly refused to accede.

"The Committee, who had spent so much time, anxiety, and trouble in these negotiations, after many remonstrances with the Managers of the Institution, seeing all their fondly cherished hopes thus blasted, and convinced that they could no longer remain in office with honour to themselves, or usefulness to their constituents, unanimously resigned. The Class, before finally resolving on what step they should take, and still anxious to obtain the consent of the Managers to its reasonable demands, nominated another, and entirely new Committee, again to negotiate with them;

but this Committee, after having had several communications with the Managers, reported that they had been equally unsuccessful as their predecessors: as the only answer they could obtain from them, was—*that it was time enough to legislate on these points, when such a highly improbable event as the discontinuing of the lectures, or their interference with the Library, should take place!!*

"In these circumstances, only one of two alternatives remained—either to sacrifice the class altogether, and permit it to return to its former state of languor and decay, or to form a separate establishment, which might secure the confidence of the mechanics, and establish security to their property. The Class adopted the latter alternative, and, without one dissentient voice, separated themselves from Anderson's Institution, and pledged themselves to support the new Association—a pledge which they have not been backward in redeeming."

On the 5th of July, the final resolution of secession was made, and a Committee of twenty-one members were appointed to frame a constitution, procure a hall, correspond with lecturers, and take measures for the formation of a library.

On the 26th of the same month, the Committee convened a public meeting of the mechanics' class, when a Constitution was laid before them, and met with their decided approbation. It related principally to the internal government of the Institution, and concluded with the following clause:—

"18. That as soon as this Institution shall have been founded, the Committee shall apply to the Magistrates and Town Council for a charter of incorporation, to secure the property of the Institution to the Mechanics of Glasgow for ever."

Last Saturday, the third general meeting was held in the Union Chapel, when the President of the Committee rose and said:—

"Gentlemen,—The object of the present meeting is to lay before you the labours of your provisional committee, in forwarding and accomplishing the views and plans recom-

mended by *you*, namely, to look after a hall, lecturer, and library. Our secretary will read to you all the information and progress of attainment regarding each of these prominent objects. I can assure you, Gentlemen, that every member of the committee has been most assiduous in the discharge of his duty; and it is impossible to detail all the little obstacles which rise up in laying the foundation of such plans as we have engaged in. The good effects that will result to the members, and to the public, from this institution, founded as it will be, upon liberal and independent principles, must be obvious to all. Every member in the class will have a voice in matters connected with the institution. All young aspirants, who possess talents and ingenuity, will have an opportunity of bringing their powers into active and useful employment; as the committee of management will be ready to countenance any person who may be disposed to give a lecture, or lectures, upon any part of the whole range of art or science, if not interfering with the regular lectures, to the class, on chemistry and mechanics. Our city is daily increasing in population, riches, and liberal policy; and it must add much to her present greatness, that her mechanics and tradesmen should have the wisdom, and public spirit, to found an institution of themselves, and upon their own resources, without the smallest assistance from their more wealthy brethren. There is a liberality and independence of mind, a love of science, and a thirst for intelligence, amongst the operatives of Scotland, and in no place has it been so remarkably displayed, within the last ten years, as in Glasgow; and it is the more to be prized that these dispositions have taken root amongst her ingenious and industrious artisans—those who form the basis of all her wealth and commercial greatness. Every well-wisher to his species, and to his country, must prize, exult in, and hail with delight, such noble aspirings—such laudable and well-directed energies! If persevered in, as we have no doubt they will be, their results will be most prodigious—not anarchy and confusion,

but the calm and cheering effects of improvement in the practical arts and sciences, intellectual excellence, progressive happiness, and a general increase of useful benefits and commercial wealth, amongst her inhabitants."

Mr. Hugh Barclay then rose, and read the Report of the Committee, the heads of which were—first, that 374 individuals had already subscribed from half-a-guinea to one guinea each per annum—2dly, that a good library had been selected, which would cost about 200*l.*, one-half of which would be required at present; upwards of 100 volumes had been already given to the Institution by the Committee—3dly, that three townsmen of considerable talent and celebrity had offered their services gratuitously, the proceeds of their lectures to go for the support of the Institution—and that, in the main branch of chemistry and mechanics, the Committee had corresponded with Mr. Steel, Lecturer to the Paisley Philosophical Institution, who had offered his large and valuable apparatus, and would give the necessary number of lectures, for a sum that might be less, and could not be more, than 150*l.*—4thly, that the Committee had the offer of two Halls, either of which would contain a very numerous Class. The Report concluded with thanking Dr. Mackenzie for his very ready acquiescence in admitting Mechanics to his Lectures on Popular Anatomy at half the usual fee—and by making a powerful appeal to the meeting for continued and earnest support.

Several letters were then read, one from Mr. James M'Fadyen, offering to lecture on Natural History, for the benefit of the Institution, gratis; a second from Mr. Robert Hunter, offering to lecture on Animal Economy; a third from Mr. Steel, offering to Lecture on Chemistry and Mechanics, provide a good apparatus, and lend his extensive collection of minerals; after which, the President intimated that he had been authorized by Mr. Warren to state to the meeting an offer from that Gentleman, to give a lecture, or course of lectures, on Painting, for the benefit of the Institution; and that he had received a letter from Leonard

Horner, Esq. with the 1st and 2d reports of the Edinburgh School of Arts, and an offer of support and information.

After these letters were read, which severally elicited much applause; several resolutions were put and carried; which terminated the proceedings of the evening.

It is unnecessary to say that this Institution has our most cordial wishes for its success—not, certainly, in opposition to any other, because we neither know nor care which is right, or which wrong, but because it is likely to disseminate still more the love of science in our city. It is to the glory of Glasgow, that while the lower orders, or rather, the useful classes, of other large Towns are frequently most *uselessly* employed—wasting their money and spending their time in rioting and debauchery—ours are imbibing light from that science which is the sun of the world—exploring with Boyle and Lavoisier the hidden and vast powers of matter—soaring with Newton and Franklin through the boundless realms of space—viewing with Harvey and Hunter the various, the mysterious, and the wonderfully-complicated machinery of man, and through all knowledge and art banqueting with the immortal Milton on that

> "—— Perpetual feast of nectar'd sweets
> Where no crude surfeit reigns."

LVIII.—*On Purifying Animal Charcoal, for the use of Vinegar Makers, &c. By* Nicholas Mill, *Esq. With a Query on gilding Silver-Wire.*

Sir; *Bridge Cottage, Camberwell, Oct.* 6, 1823.

As large quantities of animal charcoal are now used by vinegar-makers, *without any kind of preparation*, for the purification of vinegar; and they are not at all sensible of the great loss to which they are exposed from such practice: I have taken the liberty of forwarding you some useful information, for the benefit of the community, which I have obtained by experience.

All animal charcoal, as prepared from bones, for the purposes of commerce, contains a considerable quantity of undecomposed carbonate of lime. When vinegar is added thereto, a brisk effervescence ensues, *and a very large portion of the vinegar* combines with the lime, expelling the carbonic acid, forming acetate of lime; thereby depriving the vinegar of its strength, and occasioning a very material loss to the manufacturer.

Animal charcoal, therefore, previously to its being used for the purpose of purifying vinegar, should be freed from carbonate of lime, and all the metallic matters which it may contain, by a weak solution of muriatic acid.

When all effervescence has ceased, after adding this acid to the charcoal, the acid should be allowed to remain upon it a few hours, and be then poured off. The charcoal must then be well washed in water several times; and when dried, it is fit for the manufacturer.

Perhaps you will oblige me, also, by eliciting, by inquiry from some of your correspondents, the method employed in gilding silver, for wire, thread, and lace; which, it would appear, is confined to very few hands; and the greatest secrecy is observed in the process.

I am, Sir,

Your obedient servant,

T. GILL, *Esq.* N. MILL.

We believe we cannot, at present, better comply with the wishes of our esteemed Correspondent, than by re-publishing the following excellent Article, from the late celebrated *Dr.* WM. LEWIS'S *Commercium Philosophico-Technicum.*

LIX.—*On the Preparation of Silver-gilt Wire.*

THERE is very little wire made entirely of gold; and this chiefly for one particular purpose, that of filligree work. What is commonly called gold-wire has only an exterior covering of gold, the internal part being silver. A rod of

silver, above an inch thick, two feet in length, and weighing about twenty pounds, is coated with gold; and then reduced into wire, by drawing it successively through a number of holes made in metallic plates, diminishing insensibly in a regular gradation.

The purity of the gold employed for this use is a point of the utmost consequence; for on this principally depends the beauty and durability of the colour of the laces, brocades, and other commodities prepared from it; and, unhappily, there is more room for abuse here, than in gold-leaf, the extension of the metal in this form, being less affected by an addition of alloy. The boasted superiority of the French laces to the generality of those made in England, for which various causes have been falsely assigned, appears to be wholly owing to a difference in the fineness of the gold: our workmen have, of late years, had finer gold put into their hands than formerly, and the produce has been judged not inferior to that of France; nor is it to be doubted, that the English artist, acknowledged not to be wanting in manual dexterity, will, with equal or superior materials, produce an equal or superior commodity. It should seem, therefore, necessary, for the purposes of so important a manufacture, where so much depends upon the purity of the gold, not only to employ it in the purest state to which it can be brought by the usual methods of refining, but even to seek for means of purifying it to a greater degree, than any of the common processes are capable of doing.

With regard to the silver, which makes the internal body of the wire, its fineness is of less importance. I have been informed, by some experienced workmen, that there is an advantage in its being alloyed; that fine silver, on being annealed in the fire, becomes so soft, as to suffer the golden coat, in some measure, to sink into it; and that the admixture of a little copper communicates a sufficient hardness, for preventing this inconvenience. Accordingly, the French silver for gilding is said to be alloyed with five

or six penny-weight, and ours with twelve penny-weight, of copper, in the pound troy. Some have thought that this over-softening of the silver might be equally prevented, by using less heat; and that fine silver, receiving a smoother surface than such as is alloyed, must shew the golden covering to better advantage. How far these presumptions are well founded; or how far the manufacture is affected, by the above differences in the quantity of alloy, I cannot take upon me to determine.

The gold is employed in thick leaves, prepared on purpose for this use, which are applied all over the silver rod, and pressed down smooth with a steel burnisher. Several of the gold leaves are laid over one another, according as the gilding is required more or less thick. The smallest proportion allowed by act of parliament is 100 grains of gold to a pound, or 5760 grains of silver. The largest proportion, for the best double-gilt wire, as Dr. Halley was informed by the workmen, is 120 grains to a pound; though I am told that, of late, the proportion of gold has been increased.

The first part of the drawing process, as well as the preparation and gilding of the silver rod, is performed by the refiner, who uses plates of hardened steel, with a piece of tough iron welded on the back, to prevent the steel from breaking. In this back part, the holes are much wider than the corresponding ones in the steel, and of a conical shape; partly, that the rod may not be scratched against the outer edge, and partly for receiving some bees'-wax, which makes the rod pass more freely, and preserves the gold from being rubbed off. The plate being properly secured, one end of the rod, made somewhat smaller than the rest, is pushed through such a hole as will admit it, and laid hold of by strong pincers called clamps, whose chaps are toothed somewhat like a file, to keep the rod from slipping out, by the violence necessary for drawing it; the handles or branches of the clamps are bent upwards, and an oval iron loop put over the curvature; so

that the force which pulls them horizontally by the loop, serves, at the same time, to press them together: to the loop is fastened a rope, whose further end goes round a capstan, or upright cylinder, with cross-bars, which requires the strength of several men to turn it. The rod, thus drawn through, is well annealed, then passed in the same manner through the next hole, and the annealing and drawing repeated; less and less force sufficing, as it diminishes in thickness: when reduced to about the size of a large quill, it is delivered in coils to the wire-drawer.

The remainder of the process requires plates of a different quality; those of steel, whether in a hard or a soft state, being now found to fret the wire, or to raise a bur upon its surface, and strip off the gold. The plates for this part of the work are brought from Lyons, in France*: the holes are drilled in them here. They are formed of a metallic mass, whose composition is kept a secret, but whose prevailing ingredient is plainly iron: I have begun an examination of this metal, and shall communicate the result of the experiments in one of the future numbers of this work†. There are two sorts of these plates; one, of considerable thickness, for the wire in its larger state; the other, only about half as thick, for the finer wire, where less force is sufficient in the drawing. There are considerable differences, also, in the quality of the metal itself, not to be distinguished by the eye, or any otherwise than by repeated trials: such of the thicker plates as are found good are valued at a high price. The Lyons plates, though brittle, have sufficient toughness to admit of the holes being beaten up, or contracted, by a few blows of a hammer; so that when any of them have been

* During the late war, however, many were made in the United Kingdom, and sold as Lyons plates; without the workmen perceiving any difference in their quality.—Editor.

† We regret exceedingly, that the learned author did not meet with sufficient encouragement to enable him to continue his Work. We, however, are in possession of some facts concerning the Lyons plates, which we may hereafter lay before our readers.—Editor.

widened, by a length of wire being drawn through, they are thus reduced again to the proper dimensions for preserving the gradation: the holes, after each beating up, are opened by a long slender instrument called a *point*, made of refined steel; one end of which, to the length of about five inches, is square, and serves as a handle; the rest, about twice as long, is round, and tapered to a fine point. The first holes, being soonest gulled, or so far worn as to be unfit for bearing further reductions, the next to them, grown likewise wider, supply their places, and are themselves successively supplied by those which follow; whence, as each plate is furnished with several more of the small holes than are wanted at first, it continues to afford a complete series after a considerable number of the larger have become unserviceable. Great part of the dexterity of the workman consists in adapting the hole to the wire, that the wire may not pass so easily as not to receive sufficient extension, nor so difficultly, as to be broken in the drawing. For determining this point with greater certainty than could be done from the mere resistance of the wire, he uses a brass plate, called *a size*, on which is measured, by means of notches, like steps, cut at one end, the increase which a certain length of wire should gain, in passing through a fresh hole; if the wire is found to stretch too much or too little, the hole is widened or contracted. As the extension is adjusted by this instrument, there are others for measuring the degree of fineness of the wire itself: slits of different widths, made in thick polished steel rings, serve as gauges for this use.

The wire-drawer's process begins with annealing the large wire received from the refiner: this is performed by placing it coiled up on some lighted charcoal, in a cylindrical cavity, called *the pit*, made for this purpose, under a chimney about six inches deep, and throwing more burning charcoal over it; the pit having no aperture at bottom to admit the air, the fuel burns languidly, affording only sufficient heat to make the metal red-hot, without endan-

gering its melting. Being then quenched in water, for the sake of expedition in cooling it, though the metal would, doubtless, be softened more effectually, if suffered to cool leisurely; one end of it is passed through the first hole in the thick plate, and fastened to an upright wooden cylinder six or eight inches in diameter: in the top of the cylinder are fixed two staples; and through these is passed the long arm of the handle, by which the cylinder is turned on its axis by several men. In the continuation of this part of the process, called *degrossing*, the wire is frequently annealed and quenched, after every hole, or every other hole, till it is brought to about the size of the small end of a tobacco-pipe: and in this state it is cut into portions for the fine wire-drawer.

In this last part of the wire-drawing process, annealing is not needful; but it is still necessary, as before, to wax the wire afresh at every hole. Much less force being now sufficient for drawing it through the plate, a different instrument is used: a kind of wheel, or circular piece of wood, much wider than the foregoing cylinder, is placed horizontally: in its upper surface, are some small holes, at different distances from the axis; and into one or another of these, according to the force required, is occasionally inserted the point of an upright handle, whose upper end is received in a hole, made in a cross-bar above. From this, the wire is wound off upon a smaller cylinder, called a *rotchett*, placed on the spindle of a spinning-wheel; and this last cylinder being fixed on its axis, behind the plate, the wire is again drawn through upon the first; and being at length brought to the proper fineness, it is annealed, to fit it for the flatting-mill. This annealing is performed in a different manner from the foregoing ones, and with much less heat; for if the wire was now made red hot, it would wholly lose its golden colour, and become black, bluish, or white, as I have often experienced, in different parcels of gilt wire. Being wound upon a large hollow copper bobbin, the bobbin is set upright, some lighted charcoal, or small-

coal, placed around it, and brought gradually nearer and nearer, and some more small-coal put into the cavity of the bobbin; the wire being carefully watched, that, as soon as it appears of the proper colour, it may be immediately removed from the heat. This is an operation of great nicety, and is generally performed by the master himself. The wire, though it in good measure retains the springiness which it had acquired in the drawing; and does not prove near so soft as it might be made, by a greater heat, is, nevertheless, found to be sufficiently so, for yielding with ease, to the flatting-mill.

The flatting-mill consists of two rolls, turned in a lathe to perfect roundness, exquisitely polished, placed with their axes parallel, one over the other; set by screws, till their circumferences come almost into contact, and both made to go round by one handle: the lowermost is about ten inches in diameter; the upper, commonly little more than two; though some make it considerably larger; and indeed, it would be more convenient, if made as large, or nearly so, as the lower: their width or thickness, is about an inch and a quarter. The wire, unwinding from a bobbin, and passing first between the leaves of an old book, pressed by a small weight, which keeps it somewhat tight; and then through a narrow slit, in an upright piece of wood, called *a ketch*, which gives notice of any knot or doubling; is directed, by means of a small conical hole, in a piece of iron, called *a guide*, to any particular part of the width of the rolls; that, if there should be any imperfection or inequality of the surface, the wire may be kept from those parts; and that, when one part is soiled, by the passage of a length of wire, the wire may be shifted, till the whole width of the rolls is soiled, so as to require being cleaned and polished anew, with the fine powder called putty, prepared by calcining a mixture of lead and tin: the workmen value the rolls, from the number of threads they will receive; that is, from the number of places, which the wire can thus be shifted to: good rolls will receive forty threads. The wire

flatted between the rolls, is wound again, as it comes through, on a bobbin, which is turned by a wheel fixed on the axis of one of the rolls; and so proportioned that the motion of the bobbin just keeps pace with that of the rolls.

[*To be continued.*]

LX.—*On the Substitution of Fulminating Mercury, in place of the Detonating Compositions into which Chlorine of Potass enters, as a Priming for Percussion Guns. By Mr.* E. G. WRIGHT, *of Hereford* *. *With additional Remarks, by the* EDITOR.

IT has been a just subject of complaint with sportsmen who use the percussion locks to their guns, that the powder made with the chlorine of potass has a tendency to promote rapid oxidation in the barrel and lock; besides generating dirt from the charcoal, after firing. I have found this inconvenience myself; and was induced to seek a remedy, by adopting a different substance, in which I succeeded to my satisfaction; and I shall feel obliged, if you will allow me, through your means, to make known the discovery, which may not only prove interesting to sportsmen, but to many of your scientific readers also.

In November last, Mr. Murray delivered his scientific and instructive lectures on chemistry, in this city; and in consequence of his observations on *fulminating mercury*, some experiments I had made with that substance several years ago in firing gunpowder, were brought to my recollection; and soon after he left us, I was induced to make the powder, and to try it with the copper caps; when I found it, in every respect, superior to the chlorine of potass preparation, and shot with it the remainder of the winter.

Its advantages are:—It does not create rust so rapidly as the powder now used; it is not affected by damp or

* From No. 305 of The Philosophical Magazine and Journal, in a Letter addressed to the EDITORS.

moisture; and from every severe test I have given it, I do not believe it so liable to explode,—and in case of such accident, as its force does not extend so far, its effects would not be so destructive. I am aware it is asserted, that fulminating mercury will not fire gunpowder; but if any one has a doubt on this point, by procuring a percussion gun, he may try the experiment, and be fully satisfied; taking care in loading, that the gunpowder is forced by the wadding to the point of contact with the fulminating compound.

My method of preparing the fulminating mercury is as follows:—I place two drachms of mercury in a Florence flask, and pour six drachms (measure) of *pure* nitric acid on the mercury: this I place in a stand, over a spirit lamp, and make it boil till the mercury is taken up by the acid;—when nearly cold, I pour it on an ounce (measure) of alcohol, in another flask. Sometimes *immediate* effervescence ensues, with the extrication of nitrous ether; and often, I have been obliged to place the mixture over the lamp, till a white fume began to rise, when the effervescence followed. I suffer the process to continue, removing the lamp, till the fumes assume a reddish hue; when I pour water into the flask, and the powder is precipitated. I pour off the water, and add fresh, repeatedly; permitting the powder to subside each time before the water is poured off, so as to free the substance, as much as possible, from the acid; and then I pour it on a piece of filtering-paper, and place it in an airy room to dry. It should be kept in a *corked* (not stoppered) bottle. Sometimes the powder is quite white, and at other times light brown, in colour; but this is of no consequence.

To fill the caps, I use a small ivory pin, hollowed into a scoop at one end, to take up the powder, and made flat at the other, to fit the bottoms of the caps; I place a very small portion of the powder in a cap, just sufficient to cover its bottom; and then dip the flat end of the pin into a strong tincture of gum benzoin, but so as only to moisten

it a little; and press the pin, so moistened, upon the powder in the cap, and then gently turn it round, so as to secure the powder in the cap; the tincture acting as a varnish on the surface of the powder.

After a little practice, a great number of caps may be prepared in a short time in this manner; and, I have no doubt, the fulminating mercury will be preferred, on trial, to the percussion powder at present used. Several of my sporting friends have tried some caps I gave them, charged with the fulminating mercury; and all agree, that it is superior to the common preparation from chlorine of potass.

The fulminating mercury ought to be made in an out-house; or in an unfurnished room, under a chimney; on account of the nitrous fumes extricated in the first part of the process, and the nitrous ether in the second part of it.

The fulminating mercury may be made into a paste with weak tincture of benzoin, and be granulated, for the magazine-locks of Forsyth, and other makers; but it must not be mixed with any other substance.

Hereford, September 18, 1823.

REMARKS.

Although we agree, in the main, with Mr. Wright, yet we must be permitted to differ from him in some particulars of his statement. And, first, that the detonating prime, in common use, is apt to promote rust and generate dirt, from the charcoal it contains: this, we believe, will not often be the case, unless the gun has been improperly exposed to the action of *the priming alone*, when exploded, as is sometimes done, to shew the effect of its detonation; in this case, rapid oxidation will inevitably follow: if, however, it be fired in the usual way, the effect of the gunpowder is, to drive before it, and entirely remove, all traces of the priming. Neither are the primings sold by the most respectable gunmakers liable to be affected by damp or moisture; they being made *water proof*. We must also be allowed to doubt the little liability of the fulminating mercury

exploding from accident, having repeatedly seen mischief arise therefrom; and therefore quantities of it must not be left carelessly lying about: although its explosive effect may not extend so far as that of the usual primings, yet *its energy, close at hand, is most tremendous!* It was long ago attempted to employ it instead of gunpowder, in firing artillery; but it either fractured the cannon, or, if that was made too strong for it, broke the ball to pieces, leaving it still remaining in the bore of the cannon. There can be no manner of doubt, however, of its being perfectly applicable to the firing of arms by percussion, *as prime only;* and we think Mr. Wright's, manner of applying it is exceedingly well adapted for the purpose. In making the fulminating mercury *in the large way,* however, we cannot but point out *the propriety of collecting, by condensation, the great quantity of nitrous ether extricated;* and which is of such value that it would in a great measure repay the cost of the materials employed. We strongly recommend to those persons who venture to prepare this article for their own use, to keep it in a phial wrapped around with several folds of linen or woollen cloth, to preserve it from injury; and to stop it with *a loose cork,* to avoid friction; or, which is better, to close it, by tyeing a piece of soft paper over its mouth.

LXI.—*On* BARTON's *Patent Iris Metal Ornaments*, and on Copper plated with fine Gold. By the* EDITOR.

WE have been highly gratified, in being lately favoured by Mr. Barton with several fine specimens of this beautiful manufacture, in the shape of large and small gilt buttons, struck by steel dies; upon the polished surface of which the fine linear divisions, which produce the iridescent effect, had been drawn by the point of the diamond: and in this way, many impressions may be struck before the dies become injured.

The buttons are made of *copper plated with fine gold,* in

* See Vol. II. p. 81.

the manner of plating it with silver, by rolling; a specimen of which we saw, several years since, in the hands of an eminent jeweller in New Bond Street, in the form of ornaments, raised by means of dies, and combined with others made of platina, formed in the same manner: the intermixture of the two metals, gold and platina, produced effects exceedingly beautiful; and they had the additional advantage of being likely to endure long without tarnishing from oxidation.

These gilt iridescent buttons have a most brilliant and pleasing effect, from the play of light from lamps or candles; they are not *however, at present, likely to become common,* as it is by no means Mr. Barton's intention to diminish their value by selling them at a low price, for which we cannot but applaud him.

LXII.—*On the Microscope. By the* EDITOR.

[Continued from Vol. III. p. 135.]

NEW DISCOVERY, BY MEANS OF WHICH THE ANIMALCULÆ, &c., IN FLUIDS, CAN BE VIEWED WITH THE UTMOST FACILITY.

THE great difficulty of viewing the animalculæ, &c. in fluids, *under high magnifying powers,* must have been continually felt, by all the admirers of the microscope. An improvement, therefore, which effectually removes every obstacle to this investigation,—by rendering the surface of the fluid truly plane, spreading it thinner, and extending it to a much wider space around, at the same time confining the animalculæ in more limited depth, whereby their forms and movements become most readily discernible; and also preventing evaporation from the surface of the fluid, which often dims the lens and perplexes the observer, or even puts a stop to his proceeding; as well as totally doing away the possibility of the lens dipping into the fluid, whilst adjusting its focus, as is continually happening in the present methods of viewing these objects;—will, no

doubt, be duly appreciated by the scientific world. It will render every one capable of extending the powers of the microscope in a much greater degree than has hitherto been done; and, thereby, must inevitably lead to the discovery of many of Nature's minute secrets, which for want of such facilities have remained indefinite, or entirely concealed.

The necessity of continually adjusting the microscope, from time to time, to follow the various movements of the animalculæ, in rising to the surface, or descending into the depths of the fluid, is by this discovery rendered totally unnecessary.

The evaporation of the fluid is very greatly diminished by this invention; and, consequently, the examination of it, and of the various animalculæ, &c. contained in it, may be prolonged to a much greater period than could be effected under the usual modes of employing high magnifying powers.

These great advantages may appear to many to be quite unattainable, by any thing less than a great expense in apparatus; but, when it is said, that the only addition to that usually employed, consists *in laying upon the surface of the drop of fluid a thin slice of talc or mica*, the wonder ceases; and we can only admire that so exceedingly obvious, simple, and useful a contrivance should have remained so long unemployed.

Of course, it will be understood, that the fluid should be laid upon the flat surface of a glass slip, when under examination.

The Editor, by his fortunate discovery, has been enabled to view the animalculæ in water, under the power of a lens in a single microscope, of *only one sixtieth of an inch focus*, with the utmost facility; and also, of employing the full powers of an excellent compound microscope in the same manner, the object lens nearly touching the talc.

This discovery having only been made during the course of the present month, it is quite impossible to speak of the

numerous advantages which must naturally follow from the employment of so exceedingly useful a contrivance.

The substitution of a slip of talc, in place of one of the two glass slips, usually employed in viewing transparent objects, was pointed out in Vol. II. p. 101, of this Repository, and well deserves to be universally adopted. This new application of it, however, to viewing, the animalculæ, &c., in fluids, will now render slips of talc an indispensable part of the microscopic apparatus: in their absence, one of the round talcs, usually to be met with, will be found highly useful on many occasions.

Instantly upon the talc touching the surface of the fluid, the capillary attraction between the talc and the slip of glass, disperses it on every side, and produces most of the beneficial results described in the beginning of this article. The others follow as matters of course.

The slip of talc should be rubbed as little as possible, in cleaning it, as it is exceedingly liable to become scratched, to lose its polish, and to be dull or discoloured; when either of these is the case, it should be exchanged for another slip. The defect, however, is of no great consequence, on account of the low price of talc, it being to be had retail, at the price of eighteen shillings the pound; and a sheet of it weighing only one ounce, is sufficient, when cut into pieces of perhaps half an inch broad, and an inch and a half long, to make many slips, when properly subdivided, as it should be by means of a thin blade of *horn*; the employment of any harder material ought to be avoided, lest it should scratch the talc.

LXIII.—*On a New and Successful Method of Study, pursued in the Education of a Young Man in Paris. By Mr.* B. TAYLOR.

SIR, 43, *Manor-Place, Walworth, Oct.* 9, 1823.

A FEW years' instruction in France, and more especially in Paris, of English or American Youths, if rightly conducted,

is not expensive, and is of the greatest importance both to their progress in useful learning, and their respectability in society.—Experience enables me to shew, in the clearest light, its importance; and I do this with great pleasure, in order to benefit those English or American parents, who are readers of the *Technical Repository*.

In March, 1819, I left London; having under my care a youth, twelve years of age; and who knew no more of the French language, than is generally acquired by boys, who have been taught it, one year, in the routine of other matters, at a common boarding-school; and from which he was just then removed.

I stopped a few days at Rouen, to examine and inquire into its principal boarding-schools. Their terms were 1000 francs per annum, and the masters represented how greatly a stranger would be benefited by finding his native tongue spoken, not only by several of their pupils, but also by the teachers. Now it happened, that I had reasoned quite differently on this subject:—and it being represented to me, that there were thrice the number of good boarding-schools in Paris, and most of them at a less price; I determined to go there; where I soon found a school, in a retired and pleasant situation, which had been recently established, by a very respectable young man: he had only fourteen boarders, and *not a word of English was spoken or understood by any person in the house.* Here I resolved to place my charge; but, as I told the Master, only for one month; by way of experiment:—however, if the boy made any considerable progress, he should stay longer. His terms were eight hundred francs per annum. I paid him for one month in advance, and continued to do so, punctually and uninterruptedly, every successive month, for *thirty-five months.*

My charge being thus fixed in a small, but well-regulated, institution, where he could hear *nothing but French spoken*, the progress he made in this language was such, that, in a few months, he commenced the study of the Latin

tongue also; giving for reason, "that all the other boarders studied it, and because it would be an agreeable change to fill up his time." He acquired this (to him) new language, with such facility, that, in twelve months' time from his beginning to study it, the master desired me, on the opening of the College *de Bourbon*, to let him go every day, with some of his superior pupils, to that celebrated College; where, the very first time that the class in which he was placed was arranged for a trial of its strength, he obtained the seat of honour, and the decoration of merit.

At the College *de Bourbon*, he was encouraged, by the Professor, to study the Greek grammar: this language discovered to him the origin of so many Latin and French words, that he felt the labour of his studies fully recompensed, every step he made.

From the College *de Bourbon* I removed him to the College *de St. Louis*; because that was situated in the most scientific part of Paris. He now left his boarding-school, and lodged at my Hotel.

The whole of his time was now fully employed, either in studying, with aspiring young men, at College, or at the *Jardin des Plantes*; and in attending different courses of literature under private Teachers, who explained to him the language of Virgil and Xenophon. This successful experiment terminated, on our leaving Paris, in Oct. 1822.

This youth was born in America: he is now only in his 17th year, and is established as a Teacher of languages, in a large boarding-school, in the North Western part of England.

I am, Sir, your obedient Servant,

T. GILL, *Esq.* BENJAMIN TAYLOR.

LXIV.—*On Encouraging an extended Growth of Potatoes; on the Manufacture of Farina or Flour from them; and on applying it to make Sea Biscuits, Bread, Pastry, &c.* *By* JOHN WHATELY, *Esq.*

(Continued from p. 282.)

THIS, then, is one of the advantages which will attend the consumption of potatoe flour in bread; the earth

yields it so abundantly, that the very first year's cultivation of potatoes for that purpose, to the extent of only 25,000 acres, would relieve us from the necessity of any foreign importation; and, instead of importing, we should speedily become an exporting country.

Potatoes are well known to possess such highly-nutritive properties, that it seems hardly necessary to enter upon that subject:—they constitute, in their natural state, the principal food of the Irish; and they are daily forming a great part of our own. This farina, or flour, which contains the substantial, alimentary properties of the root, deprived of its watery particles, cannot but be highly nutritious:—the use of it, therefore, in bread, is not likely to be the subject of dispute, provided it is in that state palatable, and can be afforded at a price not exceeding that of wheaten flour. To prove that it possesses the first-mentioned property, I have only to refer to the bread produced to the Society, containing different proportions of this flour; any, and all of which will, I believe, be found as wholesome and agreeable as bread made wholly of wheaten flour. In some respects it seems improved; as it keeps much longer, and it rises and becomes very light and agreeable, when toasted. Upon the second question, I shall be able to shew satisfactorily, that the flour of potatoes can be produced at a cheaper price than the flour of wheat: all objection, therefore, to its use in bread, is not only removed, but I conceive the most important advantages will follow from its adoption. In the specimens before you, one-fifth of the farina is the smallest proportion made use of; and two-thirds of farina and boiled potatoes together, when in bread, the largest: calculating, however, that no greater proportion than one-fifth should be generally introduced: in that case, the saving of wheaten flour would be immense.

The population of Great-Britain consists, according to the latest returns, of upwards of twelve millions and a half; and, of this number, it may be conjectured, that about ten millions consume wheaten bread; each individual's con-

sumption has been considered equal to a quarter of wheat per annum; the introduction of potatoe flour, therefore, generally, would produce a saving of two millions of quarters of wheat per annum: and, instead of being, as we now are, an importing nation, we should, after supplying our present deficiency, have a surplus of 1,500,000 quarters for exportation; which, at the present permitted export price, under 54*s.* per quarter, would be equal in value to four millions sterling! That this surplus would not be obtained, without some sacrifice of other crops, I am ready to admit; but, when the increased productiveness of the potatoe is considered; when it is calculated that large tracts of land may be cultivated upon this system, that would not be cultivated upon any other; and that the plan may be generally adopted, which prevails universally in Ireland, and has the recommendation of distinguished agriculturists in this country, of making the potatoe crop precede the crop of wheat, the sacrifices would, upon the whole, be few, and the advantages immense. I know that objections exist, from the scarcity of manure, &c., but I am satisfied that many of them would yield in practice:—The poor Irish contrive to manure the land, and to produce crops that serve to form the winter supply of the city of Dublin, in situations distant from cities, and where artificial manure is not to be had;—lime, sand, sea-weed, are all excellent, and are in many places easily procured; the burning of the surface in rough uncultivated land, is almost sure to produce a large crop, and is generally one of the first, as it is found one of the best, preparatives to cultivation: the manure from hogs has been stated to afford very great returns, and, as it is almost essential to the economical pursuit of the business of manufacturing the potatoes into flour, that many hogs should be kept, for the purpose of consuming the skins, refuse, &c., it is a manure that would be abundant in those places where the manufacture was introduced. Perhaps no situations would so strongly feel the benefit of this system, as those which are remote

from sea-ports, and distant from water-carriage: The ground is now necessarily employed in pasture, or it remains waste. The expense of carriage is an insurmountable bar to the pursuit of agriculture. But let us now consider the situation of a farmer adopting this system; he chooses a remote part of the country, where, perhaps, cultivation did not before exist;—he takes the land, at probably one-fifth part of the rent which he would pay in more frequented spots, and he either invites the manufacturer of the farina to settle along with him, or he resolves to become a manufacturer himself: the first year, he begins by burning and paring the surface of a part of his land, and by this preparation ensures an abundant crop.—He sows, the next year, barley or oats on the land thus cleaned and prepared, which will serve as food for his cattle, and for the large stock of hogs, that, as a manufacturer of farina, he must support; and he proceeds to bring a further part of his land under cultivation by the same means.—The potatoes are manufactured on the farm, and if he could afford to send the potatoes seven miles to market, in their original state, he can, without disadvantage to himself, convey them fifty in their manufactured state, as they are then reduced to about one-seventh or one-eighth part of their bulk. His hogs supply him with such a considerable quantity of manure, in addition to that of his farm-yard, as will enable him to maintain a constant rotation of potatoe and light corn crops:—His expense in machinery is small, and the waggon that carries his flour to market, brings back his coals, his groceries, and his household requisites, without additional expense. It would be necessary for him to have a considerable number of labourers, and it would be his interest to attract them around him, by allowing them a small portion of land; and, by being himself the purchaser of their superfluous produce, he would speedily raise a colony about him; and, as the source which gave it life, is connected with our subsistence, and the just necessities of our nature, coeval with our wants; its pro-

sperity must be ensured so long as we continue in the disposition to supply them. In the general complaint of the scarcity of farms, and the high rents which lands at present bear, perhaps no speculation offers stronger inducements to the young farmer, who can command a moderate capital, and who is contented to forego some of the gratifications of a large society. If he possesses activity and enterprise, and has engaged his land upon the favourable terms upon which it ought to be had, at a distance from market, his success, in a few years, will be certain, provided the system meets with support from the public.

One of its many advantages consists in the incorruptibility of the farina; it is not, like the flour of wheat, liable to decay, but it may be preserved for years, sound and good, perhaps improved, but certainly uninjured, by age. Thus, our supply will be at all times rendered more equal, and the year of abundance will more effectually contribute to alleviate the scarcity:—scarcities themselves are likely to be of less frequent occurrence, as we should have the advantage of two essential crops instead of one; and the weather injurious to wheat, is not unfrequently favourable to the crop of potatoes, and vice versâ. I must also observe, that the farina forms an excellent ingredient in sea-biscuit, in the proportions of two parts of farina to three of wheaten flour, or even of three parts farina to four of wheaten flour: a composition of this sort is more likely to resist the effects of climate, from the incorruptible property already mentioned, than if the biscuits were wholly made of wheaten flour.

Such are some of the more leading advantages likely to be produced by the proposed introduction of the flour of potatoes into bread, and the change of system to which it would give rise. We are now, perhaps, on the eve of another alteration in the Corn Laws, calculated to render the present high prices perpetual. A Committee is sitting upon them, composed of men of landed property; and I have heard, that it is in contemplation to prevent the im-

portation of foreign wheat, when the price of British wheat is under 96*s.* per quarter. This, then, is peculiarly the moment to introduce an alteration in the system, which would render such a measure unnecessary, and which, instead of perpetuating high prices, would produce amongst us all the blessings of plenty. They may be summed up in these words:—We shall have a greater regularity, and a certain reduction of price; an immense increase of consumable food; its more equal distribution through years of scarcity, and years of plenty;

A consequent diminution of the Poor's Rates;

An increase of comforts to the poor, and to all classes of Society, and a great accession to our resources in every branch of national wealth.

London, April 29th, 1813. J. WHATELY, Jun.

(*To be continued.*)

LXV.—*Mr.* S. JONES *on successfully Preventing the Ill-Effects of a large Dose of Opium, by means of the Cold Affusion recommended by Mr.* SEPTIMUS WRAY, *Surgeon. With Remarks by the* EDITOR.

Red Lion Passage, Fleet Street, Oct. 13th, 1823.

SIR,

AMONG the varied calamities to which humanity is subject, there is none more distressing to the feelings, or repugnant to a sound and considerate mind, than that of self-destruction; it stands without a parallel; nor can it be compared to any transaction in the whole compass of nature: no animal, except the human being, was ever known, intentionally, to commit a fatal violence upon itself. Whatever steps are taken to effect this dreadful purpose, whatever are the means employed, the object is the same; and, if any measures can be adopted to frustrate such an intention, the author of them is justly entitled to respect and thanks from the community. All, therefore, who are anxious to alleviate the sufferings of their fellow-creatures, will be happy to learn that the baneful effects of one of those mischievous agents most commonly employed on these occasions, may

be arrested and subdued, by the use of remedies that are to be easily procured, and which can be applied with the greatest facility:—and, if it be not undeserving of a place in your Repository, I am desirous of submitting the following case, of an attempt at self-destruction by crude Opium, which was successfully prevented by the prompt affusion of cold water, as recommended by Mr. Septimus Wray. With this method I know that you are acquainted; it having appeared in one of your volumes*: yet, as it sometimes happens that a valuable discovery, satisfactory and convincing in its results, but which is not called forth into action by the common concerns of life, becomes neglected for the want of repeated examples to arouse the attention to its importance, I trust the ensuing detail will be found useful; as it strongly corroborates former testimonies to the efficacy of this practice, and also tends to shew, that we may anticipate successful results, even in cases where the patient is, apparently, at the very point of death.

On Monday night, the 6th of this month, between eleven and twelve o'clock, as I was passing through Fleet-Street, I perceived a crowd at the door of Mr. Jones, Chemist and Druggist; and, on inquiring into its cause, was informed that a woman lay there who had taken poison. Being myself a little engaged in parochial concerns, as one of the Trustees for the Poor, I considered it my duty to investigate the matter, and accordingly proceeded to the door, where, on my being recognised, admission was readily gained; and I saw a woman in a most profound stupor, with an attendant pouring water over her head. It immediately occurred to me, that, as it was then late at night, the most prudent mode of proceeding would be, to have the unfortunate woman conveyed directly to the Poor-house, where every assistance could be afforded, and unremitting attention paid to her wants and distress. We proceeded accordingly; and, on the way, employed the cold affusion liberally; for the patient was so nearly exhausted, that the

* See Vol. II. p. 115.

neglect of this remedy, even for a few minutes, would, as I understood, have been succeeded by fatal consequences. It excited no small degree of admiration from the passengers, to see two persons supporting a female, while a third emptied a bucket of water on her naked head; and curiosity induced many to follow us, who were desirous of observing the process, and of ascertaining the object and result of our proceedings. Affusion was, therefore, constantly applied, until we arrived at the Poor-house; when the master, being summoned, instantly rose from his slumbers, and introduced us to a convenient and suitable place, where the affusions were continued for the space of two hours, before the system was sufficiently aroused, or the patient enabled to swallow two cups of warm water, to which was added some emetic substance. The case being thus far advanced, the warm water, &c., operated as an emetic, and the contents of the stomach were ejected. These draughts were repeated, with similar results, until we felt convinced that the whole of the pernicious agent was fairly washed out from the stomach. Instructions were then given to the female attendants, to undress the patient, whose clothes were soaked with water, and to put her to bed. When in bed, about a pint of warm coffee was given; but, as there was considerable weakness on the ensuing morning, some tonic and other necessary remedies were administered by the medical attendant; and she left the house on the 10th instant, perfectly well. I have great pleasure in bearing testimony to the kindness and assiduity of Mr. and Mrs. Evans, the master and mistress of the Poor-house, on this occasion; and to the compassionate anxiety with which they rendered every assistance to ensure our success, and in relieving the distress of the poor sufferer.

I do not presume to offer an opinion on the *modus agendi* of this remedy; but I can assert, from my own observation, that, in cases of persons labouring under the baneful influence of opium, affusion with cold water will restore the vital power, even after it appears to be exhausted, and the patient

almost dead; but, for this purpose, it must be applied by at least *a pailful at once thrown on the head,* and that repeated every two or three minutes; for, as soon as the effect of one shock has ceased, the excitement must be renewed by another, until the action of the system is restored; and then, but not till then, warm water and emetics should be freely administered, to urge the stomach to discharge its contents. I am, Sir,

Your obedient servant,

T. Gill, *Esq.* S. Jones.

REMARKS BY THE EDITOR.

For the *modus agendi* of this remedy, we refer to Mr. Wray, who first discovered and employed it: his paper on the subject is highly deserving of perusal, by every one who feels gratified with ingenious theory, or interested in promoting the welfare of society. The agents are as simple as possible: *cold water* is affused on the head, until, by its reiterated shocks, the nervous system regains its tone and power of action; and then *warm water* with some emetic is administered by the mouth, until the desired effect is produced, of relieving the stomach.

LXVI.—*Improved Mode of Laying-down Gas Pipes**.

The first point which the committee had to decide upon, related to the comparative merits of oil-gas and coal-gas. For this purpose they entered into a correspondence with Messrs. Taylor and Martineau, and deputed an agent to inspect one of their works, which had been erected on a small scale, at Liverpool. After obtaining the best information in their power, they finally determined in favour of coal-gas, chiefly because it could be supplied to the consumer at little more than half the price of oil-gas, and could be made equally pure.

The illuminating power of oil in comparison with coal-

* From the Report of the Committee of the Shrewsbury Gas-Light Company, Sept. 15, 1823.

gas is nearly as $2\frac{1}{2}$ to 1*. Oil-gas is sold at 50*s.* per m. cubic feet. The common price of coal-gas is 15*s.* per m. cubic feet. Making, then, due allowance for the superior power of oil, the difference in price is as 33*s.* 9*d.* to 50*s.* or about 33 per cent. But the Shrewsbury company charges only 12*s.* per m. cubic feet, which makes the difference in the proportion of 27*s.* to 50*s.* or 46 per cent.

It is to be observed, also, that oil-gas, as well as coal-gas, varies in its illuminating power, according to the quality of the material from which it is extracted, and in its unburnt state gives out an equally disagreeable odour. But there is one inconvenience belonging to oil-gas which is worth noticing, and which results from the *very property* for which it is so much celebrated. In consequence of its superior illuminating power, a proportionally less quantity is required to produce a given quantity of light. This, of course, makes a small flame of oil-gas answer the purpose of a much larger flame of coal-gas, but a small flame is more easily extinguished than a large flame—and therefore, upon a stormy night, the street lamps, which would not exhibit a flame of oil-gas equal to half the size of the flame of coal-gas, would, in all probability, be generally blown out.

Having, for these and other reasons, decided in favour of coal-gas, the next business of your committee was to find out where it was manufactured of the best quality and at the least cost. Among the places visited, in order to ascertain this point, Oxford at that time presented the most brilliant and beautiful light from coal; but the method of purifying at Oxford was very expensive, which caused some demur as to its adoption. While deliberating upon this matter, your committee heard a favourable report of the Derby gas-works; and the late lamented chairman

* This proportion is taken after considering the number and weight of the authorities upon both sides of this disputed point, and also the different qualities of the gas used in the experiments. But laying aside all experiments made in the Laboratory, the actual application of oil-gas at Liverpool in 1820, was found to be in the ratio of 1 to 2; i. e. oil-gas was practically taken as only possessed of double the illuminating power of coal-gas.

made a purpose journey to Derby with a view of obtaining correct and certain information. Being quite satisfied of the superiority of these works over all those which had hitherto fallen under their notice, your committee resolved to engage the services of Mr. Wigston, the engineer employed at Derby—and accordingly, under his direction, were set up the retorts, the purifier, the condenser, and the other necessary apparatus at your works in Shrewsbury.

Meanwhile the laying of the pipes was going forward under the management of Mr James M'Intosh, of London, according to a plan, which it may, perhaps, interest the meeting to hear explained.

In order to ensure a supply of gas on the lowest levels of this remarkably hilly town, it was determined to carry an *insulated* main (as it is called) to the bottom of the Wyle Cop, and another to the bottom of Mardol. These mains deliver no gas to the consumer, but merely convey the gas from the works to these the lowest parts of the town. The supply is given by *return* mains, which ascend on each side of the streets from the extremities of the insulated mains. And in order to make the circulation complete, a line of pipes is carried from the bottom of the Wyle Cop along the walls, and by St. Chad's church to the lowest point in Mardol. Thus the gas *everywhere* ascends, and the difficulty of getting up and down two hills which intervene between the works and the opposite extremity of the town, is entirely obviated.

The advantages which have now been mentioned, could not, however, be obtained, but at a greater expense than was at first contemplated. Yet still the works have cost considerably less than any other works upon the same scale which have hitherto been brought under the observation of your committee. The expenditure upon an establishment of the size of the Shrewsbury gas-works has usually been from 15 to 16,000 *l.* and the sum of 16,000 *l.* was named as the probable cost of the Shrewsbury works, by an experienced engineer, to whom the committee had submitted

the plan of your works. They have not, however, cost so much even as eleven thousand pounds—the exact expenditure being 10,857*l.* 3*s.* 4*d.*

LXVII—*On the Hydro-pneumatic Blow-pipe, for the Use of Chemists, Enamellers, Assayers, Glass-Blowers, &c.; invented by* JOHN TILLEY*; *with the* EDITOR'S *Observations and Improvements upon it.*

WITH A PLATE.

SIR, *London, March* 27, 1812.

BEING a travelling fancy glass-blower, I work with a Machine which I contrived for my own use, and which I have been advised, by a great number of respectable gentlemen, to lay before the Society of Arts, &c. The invention consists of a tin, or tinned-copper box, with a partition in it, reaching from the top, at one end, to within an inch of the bottom; the vessel is air-tight at this end: it is three parts filled with water. By means of a tube, reaching within half an inch of the bottom, I blow into the water, at the air-tight end; the air rises in bubbles through the water to the top, and forces the water under the partition into the other compartment. The weight of the water acts upon the air which had been blown in, drives it through a blow-pipe directed to the flame of the lamp, and keeps up a constant blast till the air is exhausted. More air may be blown in, from time to time, so as to keep the blast regular and continual. It is thus that I execute my fancy glass-blowing. The whole apparatus, including lamp and case, weighs only three pounds and a half.

I believe that I am the first glass-blower who ever worked with such a machine.

If the Society should think me deserving of any reward, it will be very thankfully received by,

Sir, Your most obedient humble servant,

To C. TAYLOR, *M.D. Sec.* JOHN TILLEY.

* From Vol. XXXI of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted the Sum of Fifteen Guineas to Mr. Tilley, for this Invention.

P. S. The apparatus is also applicable to the purposes of chemistry, enamelling, jewellery, and many other arts, and might be furnished complete, for about two guineas and a half; even when made of tinned copper.

References to the Engraving of Mr. Tilley's Hydro-pneumatic Blow-pipe.—Plate XII.

The utility of the blow-pipe, in the arts, to raise a great heat in a small object, from the flame of a lamp, is too well known to require pointing out. The assaying of minerals, the arts of enamelling, jewellery, soldering metal works, but above all the blowing of small articles in glass, are purposes to which it is better adapted, than almost any other mode of applying heat. The usual manner of producing a stream of air for blowing glass, is, by means of a small pair of double bellows, fixed beneath a table, and worked by the operator's foot; a pipe proceeds from these bellows to the top of the table, and terminates in a small jet, before which a lamp is placed, and the flame is blown, by the current of air, upon the object to be heated. The defects of the bellows are, that the stream of air is not perfectly regular, which causes a wavering of the flame, so that it does not fall steadily upon the object which is to be heated. Mr. Tilley's blow-pipe corrects these defects, by using the pressure of a column of water to regulate the stream of air, and the supply is furnished from the mouth of the operator, by blowing through a tube.—Fig. 1 is a section of this instrument; and fig. 2, shews a perspective view of it in action. A A, is a vessel of tinned iron, or copper, about 17 inches high, 5 wide, and 9 broad; the lid of which opens on hinges, and supports the lamp, B, which burns tallow instead of oil. C is the blowing-pipe, by which the air is thrown into the vessel; this, as shewn in the section, fig. 1, has an inclined partition, D, which divides it into two chambers, E and F; but, as the partition does not reach to the bottom of the vessel, the

two compartments communicate with each other underneath it; that marked F, is closed at the top, so as to be air-tight; but the other is only covered by the lid of the vessel, and may therefore be considered as being open to the outward air. The pipe C, fig. 1, is soldered air-tight, where it passes through the top of the chamber, and descends very nearly to the bottom of the vessel, deeper than the partition, D, does; so that its mouth is always immersed beneath the water. The metallic part of the blow-pipe, G, which conveys the blast of air to the flame of the lamp, is likewise soldered into the top of the chamber, F; it holds a bent glass tube, *a*, which terminates in a very small and delicate jet, and is fitted air-tight into the tin or copper tube, G. Now, by blowing into the tube, C, the air is forced out at the bottom of it, and rises in bubbles through the water into the upper part of the chamber, F; this displaces a corresponding quantity of water, which passes under the partition, D, into the other chamber, E, elevating the surface of the one column of water, and depressing the other, as shewn in the figure; the water endeavouring to return to its original level, causes a constant compressure of the air and forces it through the jet, *a*, into the flame of the lamps. By this means, it is not necesary to blow constantly with the mouth; for, though the air is forced into the receiver at intervals, yet the pressure of the water will expel it in a constant stream; and the operator will not be fatigued by the motion of the foot, necessary in working bellows; nor need even to keep his mouth at the pipe constantly, but merely to blow from time to time, as he finds the stream of air to decrease in its power.

The metal socket, which connects the glass tube or blow-pipe, *a*, with the vessel A, is made conical; and the tube, having a piece of paper first wrapped round it, is bound round with cotton wick-yarn, in a conical form, so as to fit the socket tight, and yet permit the tube to be moved in any required direction, to cause the air to act properly

upon the flame; and the curved metal tube, C, is also fixed into the other part of the same tube, in a similar manner. H H are the two sides of a tin frame, which is fixed in front of the vessels; and has grooves withinside of them, to receive a tin plate, I, which forms a screen; and can be adjusted in height, so as to keep the light of the lamp from the operator's eye; though he can see the work over the top of it: this screen is held fast, by its foot being placed between the lid of the vessel and the top of the close chamber, F.—K is one of two handles, which support the operator's arms, whilst holding a glass tube, or any other article, in the flame; and there is another like it, at the opposite side of the vessel: these handles are wrapped round with woollen list, or leather, so as to form cushions; and the vessel is steadily fixed upon a chair, bench, &c., by means of a leather strap, buckled to the loops on each side of it, and passing underneath the chair, &c.

The lamp is made of tin; it is of an elliptical, or rather, of a bean, or kidney shape, one side being curved inwards; across the centre of it, stands a metal wick-holder; having a loop on one side of it, and which is soldered to the bottom of the lamp; see fig. 3. Through this loop, the wick, of cotton-yarn, is drawn; and being cut, and then opened both ways, as shewn in that figure and in figure 5, forms a passage in its middle, through which the current of air from the jet, *a*, passes; as in figs. 1 and 5; and carries the long pointed flame upon the object to be heated. The lamp, figs. 3 and 5, is filled with tallow; which, melting by the heat, becomes fluid, and burns as well as oil, but with a less offensive smell; and, when cold, being solid, is more conveniently carried than oil. This lamp is placed within another vessel or stand, marked B, in figs. 1, 2, and 5, which supports it at a proper height; a space being left between them, all round the lamp, to receive any tallow which may run over its edge.

In using this blow-pipe, the following observations being attended to, will greatly increase its effect. The long, flat, cotton wick of the lamp, will be found to act better than the usual round cotton-wick; but, in either case, the flame which is raised will be considerable. The end of the glass pipe or jet, *a*, must be just entered within the flame, and the current of air will throw out a cone of flame from the opposite side. If it is properly managed, this cone will be distinct, and well defined, and extended to a considerable length. Care must be taken, that the stream of air does not strike against any part of the wick, as it would then be disturbed, and the cone split into several parts. (A wire pointed at its end, and bent, as shewn at fig. 4, is very convenient to smooth the air passage through the wick): the jet of air must be delivered somewhat above the wick; and as, unless the flame was considerable, there would not be sufficient for the stream of air to act upon, for this reason the wick is opened, as shewn in fig. 3, that it may expose the largest surface, and produce the greatest flame; the stream of air from the pipe should be directed through the channel or opening between the divided wick, so as to produce a cone the most perfect and brilliant. On examining this cone of flame, it appears to be of two different colours, the part nearest to the lamp being of a yellowish white, and that beyond, of a blue or purple colour.

The subject to be heated, is held in the flame, at the termination of the yellowish-white part, where it receives the greatest heat, and is not discoloured by the soot, which accompanies the white flame.

Glass tubes are, when applied to this flame, quickly rendered pliable, and may be bent, or drawn out into threads or points, and hermetically sealed; or, by blowing into the other end of the tube, it may be expanded into a small globe; or it may be made to form various other small articles, at the pleasure of the operators.

In chemistry, mineralogy, and the arts, the blow-pipe is an extremely useful instrument being capable of throwing

such a powerful heat on a small object, as can only be obtained, on a larger quantity of the same substance, in the most powerful furnaces: and with this advantage, that the process is always under the inspection of the operator; whereas he can only conjecture what passes in the centre of a furnace.

In using the blow-pipe for experiment, a piece of charcoal is generally employed to support the subject, and held in the flame of the lamp; the charcoal should be of a close compact grain, and properly burnt; for, if it is too little carbonised, it will flame like a piece of wood, and obscure the object; and if it be too much burnt, it is so quickly consumed and burnt to ashes, that the object is in danger of being lost in it. The charcoal greatly increases the heat, by reverberating the flame, and by heating the object at the opposite side; it being converted into fuel, and excited by the blast: thus creating an atmosphere of heat and flame around it, which prevents the heat from being carried off so fast, or the object being so much cooled, as if it should, for an instant, be moved out of the cone of flame, from the unsteadiness of the hand, or from accidental currents of air, which would disturb the flame, and cause such a wavering in the point of the cone as to divert it, in some measure, from the object.

In order to prevent more tallow than is necessary, from being consumed, to produce the intended effect; it is convenient to have several lamps, with wicks of different thicknesses; viz. one to hold two flat cottons (such as are used for the Liverpool lamps) of about an inch and a quarter broad; another to hold four, and a third six; or as much common cotton wick-yarn as is equal to those wicks in bulk.

Glass jets should also be provided, of different sized apertures, to suit the greater or lesser sized wicks and flames, and deliver streams of air upon them proportionately: and their jets should, for fancy glass-blowing, point upwards in a small degree.

Hogs'-lard is equal, or, perhaps, even superior to tallow, for the lamp.

The EDITOR's *Additional Observations and Improvements on the above Apparatus.*

Having sedulously attended Mr. Tilley during his operations with this valuable instrument; and also considerably assisted Dr. C. Taylor, the late worthy Secretary of the Society of Arts, &c. in making out the foregoing description of its construction and uses; besides constantly having one at hand for his own purposes: the Editor conceives that it will be desirable to afford his readers such additional information respecting it, as his opportunities of acquiring it, and his own experience in using the instrument, have furnished him with.

The greatest inconvenience he experienced, in using the hydro-pneumatic blow-pipe, arose from the frequent destruction of the glass jets, owing to their points being fused, on being left, only for an instant, in the flame, after the air had ceased to pass through them. This inconvenience, at length, became so serious, that he determined to contrive a more facile method of forming them, than by making each jet of a part of a bent tube as in Mr. Tilley's instrument. With this view, he caused a glass tube to be bent at a proper angle, which served as a receptacle for all the jets; and which were then readily formed by merely softening a portion of another smaller glass tube, by heat, and drawing it out to the required size; then softening another portion of it, at a proper distance apart, drawing it out, and so proceeding, until as many portions of the tube were so treated as were thought necessary. The tube was then cut into portions (with the help of a proper knife, to be described hereafter), so as to form the jets; and thus a piece of glass tube, long enough to have made only one of Tilley's jets, may be formed into five or six of them. This description will be more readily understood, by a reference to the additional figures in Plate XIII., where fig. 6 represents the bent glass tube, and one of the jets within it; fig. 7, the tube

contracted by drawing out, in the places marked LL; and intended to be cut asunder at the points, MMM. Figs. 8 and 9 represent two of the jets, shewn separately; the one having a finer point, and a smaller aperture in it, than the other. These jets are readily secured in the bent tube, by merely wrapping a little thin silver- or tissue-paper around them, which makes a joint that is sufficiently air-tight. Fig. 10 is a section of the knife, mentioned above, for cutting glass tubes with: it is about eight inches long, and tapers to its point; having also a wooden haft or handle fitted to it. This knife must be made of cast-steel, and be left quite hard: its cutting-edge is formed by rubbing it across, on both sides, with a shoe-maker's *gritstone*; and, in this way, can be renewed, when, in course of use, it has become smooth. This knife is greatly preferable to the three-square saw-files, ordinarily used by the barometer makers, for a similar purpose; or even to the smooth Lancashire *crossing files*, which other fancy glass-blowers employ. In case the nose of the jet is too small, it may be made larger, by cutting off more of the end of it; and it may be further adjusted, by rubbing it across, with a *rag-stone*, similar to that used by carpenters, &c.

Fig. 11 is a front view, and fig. 12 an edge view, of a pair of brass tongs, used by Mr. Tilley, in the manner to be presently described. They are made of stiff-rolled brass, about one-eighth of an inch thick, and seven inches long; and their circular ends are about two inches in diameter. He used them to flatten the stoppers of smelling-bottles, &c. by pressure, whilst hot, as well as the bottles. They were also used for pressing the red-hot ends of glass-tubes against, in order to thicken them, previously to blowing into bulbs.

Fig. 13 represents another tin-screen, used by Mr. Tilley, instead of that shewn in figs. 1 and 2, at HI, to hide the flame of the lamp from the eyes of the operator; and yet, at the same time, permit him to have a better view of his work, than could be had over the former one described:

it slides up and down, in a tin socket affixed to the end of the machine, next to the operator.

Fig. 14 is a cylindrical rod of brass, about five inches long, and three-eighths of an inch in diameter; and having one end tapered to a triangular point. This Mr. Tilley used, to widen the orifices of glass tubes, bottles, &c. with; and it is exceedingly convenient for that purpose.

It may be desirable to mention Mr. Tilley's mode of forming and adjusting the wick of his lamp, which is as follows:—Fine cotton wick-yarn is to be wrapped around the four fingers of the left hand, so as to form a flat coil, of a sufficient size to fill the loop of the wick-holder, but not so tightly as to hinder the tallow, &c., from rising freely through it. A piece of twine must then be passed through the coil, before taking it off the fingers. The lamp being next filled with melted tallow, lard, &c., the string is to be passed through the tallow, &c., and through the loop of the wick-holder; and the coil of wick-yarn must be also drawn through the melted tallow, &c. after it, and be lodged in the loop, carefully spreading it equally therein. One end of the wick, viz., that next to the operator, must then be set fire to; and, as it burns forwards, the coil of wick must be cut open, with the trimming scissors, gradually, until it is all divided, and a passage left through the middle of it, for the blast of air to pass in: it is also to be evenly trimmed on each side: it may project, through and above the loop, about half an inch.

This wick will serve a considerable time, without snuffing; provided that, on relighting it, when the tallow is solid, the end next to the nozzle or jet be only kindled, and a lump of tallow, lard, &c., be held in the flame, upon a fork, &c., so as to melt it, and let it drop upon the fore-part of the wick, to feed it, until the tallow, &c. in the body of the lamp, becomes sufficiently melted, to rise and furnish it with fuel; and thus prevent the cotton from being charred and rendered useless. When, however, it requires to be renewed, the tallow, &c., being melted, as before

mentioned, the wick may be raised, by means of a pair of forceps, pliers, &c.; and the charred parts be removed, with the scissors, by enclosing the wick lengthwise between their blades; and, closing them, let them bring away, what will readily come off: and, as in this operation the wick is partially closed, it must be again opened and smoothed, by means of the bent wire, fig. 4, before described.

A slip of oiled silk should be tied over the lower end of the blowing-tube, C, C, C, figs. 1 and 2, in order to prevent the return of a little water up it, which, otherwise, is apt to take place.

In order to adapt this machine to the purposes of the jeweller, &c., for soldering with; it will be necessary to provide an additional glass-tube, like that shewn in fig. 6, but with its upper end bent downwards, instead of pointing upwards, as in that figure.

A shallow tin-tray, with its edges turned up, and about four inches broader than the top of the machine, and as much longer, being secured upon it, by means of wire loops, affixed to the tray, and to the machine; viz., one at each side, on the end next to the operator, and another at the further end of it; and through which loops, strings are passed and tied fast; will be found exceedingly convenient to hold pieces of glass-tube, &c., and prevent them from falling off the top of the instrument.

Other fancy glass-blowers are in the habit of employing *much thicker wicks* than these described, in order to produce a flame sufficiently powerful for their work, and which they unquestionably do; but, then, it is attended with a very great waste of tallow, &c.; whereas, in this disposition of the wick, nearly the whole of the flame is carried into the current from the blast, and is usefully employed.

The Editor has lately employed this very useful apparatus, to excite the charcoal fire in his small pumice-stone furnace, by means of the very fine and gentle blast produced from one of the glass jets; and the consequence has

been, that the water contained in his portable boiler*, is now heated in less than half the time before required: and so gentle is the blast of air, that none of the light ashes of the charcoal are blown about by it; and it is now become an exceedingly useful and cheap substitute for the oil and spirit lamps, in chemical experiments.

His machine is made of *tinned copper*; and he has found, that the water keeps constantly fresh in it, and never requires changing for years together. One singular effect, however, has been produced thereby, which is, the formation of a considerable quantity of *fine oxide of tin*, very fit for polishing speculums, gold, silver, &c. May not this discovery be useful in the Arts?

LXVIII.—*On the Application of Larch Bark to answer all the Purposes of Oak Bark, in Tanning Leather; and on the Cultivation of the Larch. By* THOMAS WHITE, *Esq., of Woodlands, Durham.*†

SIR, *Woodlands, August 13th*, 1811.

IN the year 1786, my deceased father did himself the honour of laying before the Society of Arts, &c., his remarks on the improvement of this place; and in a second letter, in 1796, he wrote some further observations; since which time, the plantations, as well as the place in general, have made great progress in beauty and improvement, which induces me to trouble you with a few ideas, that I flatter myself will be of importance to the country at large, as well as of private benefit to persons in possession of woods, which you will oblige me by laying before the Society.

As the trees have now advanced, as I have before observed, to a considerable size, we have been busy for some years, in weeding them out to a timber distance; in doing which, lately, and whilst taking off the bark of some larch

* See p. 247, of the present Volume.

† From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted its Lesser Gold Medal to Mr. White, for this valuable Communication.

trees that were wanted for building purposes, our agent observed the nails of his fingers to be stained, which induced him to think, that the bark of this tree might be useful in tanning leather; a thought that struck the active mind of my father many years ago, when he was desirous of trying its virtues in this necessary and useful business, but was prevailed upon to give up the project, on being told, that a tree containing turpentine would not answer the purpose; his adviser thinking the larch was a species of the fir tribe, instead of the cedar. In consequence of this renovated idea, I was determined to have the most impartial trial made of the bark of the oak, and that of the larch, and in order to shew the latter no favour, I procured some of the best oak bark in the country, such as can rarely be purchased, and took that of the larch from a small young tree. I next purchased two calf skins, of the same value, weight, and quality; and put as much of the fine oak bark to one skin, as was applied of the larch bark to the other, both remaining in the pits the same time. During the operation, as we repeatedly weighed a certain measure of larch liquor against the oak, the latter always required an additional quantity to make the scales equal; which accounts for the skin tanned by larch, being above one pound and a quarter heavier than the other, which it was, when dried and ready for the currier, the increase being gradually perceptible during the whole business. Which of the two skins proved the best, I leave to the Society to determine; but I flatter myself, that, exclusive of the additional weight of that produced from larch, the colour of it is preferable for gloves, saddles, boots, &c.

As I am proceeding with some other experiments, one of them will, I hope, prove which of the two infusions that the skins were tanned in, will afford the greatest weight of leather, in order to produce a fair test of the intrinsic value of both trees, when applied to tanning; the result of which, I shall do myself the honour of laying before the Society at a future period.

It must be observed, that the bark of oak and birch (the two kinds used to any extent), can only be taken off the trees for a very few weeks; whereas larch bark may be collected at any period during three parts of the year; and, I believe, with almost as good effect even in winter; and, as the bark is stript off this tree with very little trouble, the expense of doing it is much less than the oak. It is unnecessary for me to inform the Society, that as oak is daily decreasing in this country, so as to require a great annual importation, the larch tree (which I believe there is little doubt of being the cedar of Lebanon) is in a fair way to be as celebrated hereafter, as it was in former times.

In my professional exertions of laying out grounds, and planting by contract, I am constantly regretting the mischief done to woods, by the want of thinning them; which some of my employers tell me they neglect doing, from the difficulty of finding sale for the weedings, which the probable source of consumption for the larch bark, will, I hope, entirely do away: and that this valuable species of tree, by being left at proper distances, will arrive at such perfection, as to be fit for most purposes, if not all, that oak is applied to; viz., in ship-building &c.

It is my intention (if my professional pursuits will admit) to publish a small treatise on the Management of Woods in general, collected from the practice of my late worthy father and myself, which I hope will be found useful.

I have sent from Durham, by the mail-coach, directed to you in a paper parcel, the two skins, with specimens of the oak and larch barks, used in the process of tanning them; and also the Currier's letter who dressed the skins, which, however, he does not think is to be laid before you.

I am, Sir,

Your most obedient Humble Servant,

To C. TAYLOR, *M.D. Sec.* THOMAS WHITE.

CERTIFICATES.

SIR, *Hexham, August 8th* 1811.

I AM convinced that the trial of the larch bark will bear the most minute inspection, and will answer all the purposes as a substitute for oak bark. The process of curing is in general ten or twelve days, and these specimens were done in twenty-four hours.—I am, your's respectfully,

To Mr. WHITE. THOMAS GRAHAM, Currier.

THE Honourable Sir JAMES STEUART, of Courtness, called at the Society's House to give testimony in favour of Mr. White's method of using larch bark for tanning: he had sent one ton of the bark to Mr. Halden, tanner, at Hamilton, whose report is much in its favour; the operation being performed in less time than when done with oak bark, and better in colour, quality and weight.

SIR, *Woodlands, 26th June*, 1812.

I AM sorry that I have not been able to send before, two pieces of leather, of a strong quality, tanned with larch bark; and which, though perfectly useful for most purposes, would have continued to great advantage some time longer in the tan-pit, for making soles of shoes.

With the specimens, I send a pair of gloves, and a remnant of leather, converted into shoes, both tanned with larch bark, by a person at Hexham; who told me that glovers would use nothing else, could they get a sufficient supply.

In addition to the equality that larch bark is upon with oak, in regard to its tanning as great weight of leather of every description; it has the advantage of being *quicker* in its operation and from its light colour, of being *preferable*, as mentioned before, for gloves, book-binding, &c.

It must be observed, that nothing has been introduced into the tan-pit, to make leather firmer, but bark.

I am, Sir, your most obedient Servant,

To C. TAYLOR, *M.D. Sec.* THOMAS WHITE.

P.S. The leather has not been five months in the tan-pit.

SIR, *Woodlands, Durham, July 10th*, 1812.

I am really ashamed to give you any unnecessary trouble, I therefore request that you will excuse this letter.

Since I did myself the honour of sending to you, on the 26th ult., a parcel of leather, by the Charlotte coach; I am informed, that during my absence from home, and after you had done me the favour to request a specimen of strong leather; my tanner, to expedite the work, had applied, occasionally, warm water, in cold weather, which may have made the leather less firm than it would otherwise have been; the time that it was in the tan-pit, also, did not exceed four months. If you, therefore, think the leather is not sufficient to pass judgment upon; I will, when my strong hides are ready, send you a specimen of much superior quality. Mr. Curwen has just written to me for some leather, to whom I mentioned the disadvantage it laboured under.

After sending you the two first skins, I put a number of others, of equal weight and quality, into each of the two tan-pits, to try which bark would prove superior in the end, and found, on taking out the leather, on the same day, from each tan-pit, although both were equally well tanned, that the larch liquid was the strongest, but did not, as in the first instance, produce much more weight of leather than the oak.

I am, Sir, your much obliged humble servant,

THOMAS WHITE.

P. S. In your last letter, you request to know the comparative expense betwixt larch and oak barks, in a given number of hides.

I have not yet sold my bark from the larch tree, therefore it is not in my power to answer this question; but as it tans faster, and will probably be at a less price, it certainly will be found an excellent substitute for oak.

SIR, *Woodlands, Sept. 21st*, 1812.

As I leave home to-morrow, for Scotland, I do myself the honour of writing to inform you, that in a few days

will be forwarded another piece of strong leather, such as I use for soles of shoes.

A tanner in this country has produced some very firm leather, with larch bark, by making it undergo the additional process usual for that purpose; but my skins acquire the solidity they possess, by the strength of the bark alone.

The longer I try the larch, the better I am pleased with it: and I am certain, that when used in an extensive way, by people that have proper tan-pits, &c., it will increase in reputation very much, and be found far more beneficial than I have been able, in my limited scale, to prove it.

I am, Sir, with the greatest respect,

Your most obedient humble servant,

To C. TAYLOR, *M. D. Sec.* THOMAS WHITE.

P. S. The leather is sent off this day for you, in London. Nov. 21st, 1812.

SIR, *Woodlands, 16th April*, 1813.

I am just favoured with your's, of the 10th inst. and am infinitely obliged by the trouble you have taken about my tanning operations.

I have enclosed a certificate, as strong as I can make it: and shall send Mr. Mackintosh, in the Haymarket, on Tuesday next, a calf-skin, one-half tanned with oak, and the other with larch; and a hide, the strongest I have at present, tanned with larch.

I do not wonder at *John Bull*'s unbelief; but I hope, in a year or two, hundreds will prove my tanner's testimony correct.

With many thanks for your kindness, I have the honour to be, Sir, your much obliged,

and most obedient servant,

To C. TAYLOR, *M. D. Sec.* THOMAS WHITE.

Durham, April 17th, 1813.

I, Thomas Farbridge, Tanner, of Woodlands, in the county of Durham, do verify, on oath, before one of his

Majesty's Justices of the Peace, that on or about the 21st of June, 1811, I put a calf-skin, weighing, when green, 12lbs., into a tan-pit, to which, at different times, I applied 43¼lbs. of larch-bark; and on the said 21st of June, I put another green calf-skin, of the weight of 12lbs. also, into another pit, and in the same manner applied, at different times, 42lbs. of oak-bark; and on one and the same day drew both these skins, when tanned; which, when dried, produced as follows: viz. The larch skin 6¾lbs., and the oak 5½lbs.; both skins undergoing exactly the same process, and the former having neither oak bark, nor any other substance of tanning quality, put into the tan-pit, but larch bark. And although the larch liquor had 1¼lbs. more bark than the other, it was infinitely stronger; for, after the two skins were tanned, I put three sheep-skins into each of the pits; and, although I drew the three from the larch liquor about twenty-one days before those put into the oak bark, they were in a better state; and, at the end of the second tanning, the larch liquor was the strongest; as I have ever found it to be after every experiment, where the weight of leather was equal.

I moreover declare, that the skin which is on the point of going to London, the one-half marked oak, and the other larch, was tanned, after being equally divided, the one part with 43lbs. of larch bark, and the other with an equal weight of oak bark, being put into the tan-pits on the same day, about the 21st of May last, and drawn together about a month ago; and that nothing of a tanning quality was put into the larch-pit, but larch-bark alone, and the process exactly the same in regard to each half, as in the first experiment.

I moreover declare, that the specimen of hide leather sent to London in November last, as well as the hide now to be sent, although tanned in a pit with a number of others, underwent exactly the same process, without any bark or mixture but pure larch bark: and although no comparison was made betwixt it and oak, I am cer-

tain it would have required as much bark of the latter, to have produced leather of equal good quality and weight.

THOMAS FARBRIDGE.

Sworn before me, at the place and date above written,
EDWARD DAVISON,
One of His Majesty's Justices of the Peace for the said County.

Durham, April 17th, 1813.

I, Thomas White, of Woodlands, in the county of Durham, do verify, on oath, that to the best of my knowledge, what Thomas Farbridge attests is true; and, as I have often, daily, and sometimes several times a day, inspected the tanning process, it was almost impossible that any deception could be practised without my discovering it.

THOMAS WHITE.

The said Thomas White sworn to the above statement before me, EDWARD DAVISON.

*** Mr. White, during the above correspondence with the Society, having informed the Secretary, that his deceased father had been favoured with Nine Gold and Two Silver Medals from them, for planting the trees he is now converting to so valuable a purpose; the Society thought it would render an essential service to the Public, to trace the progress of the trees, from the time of their being planted, to that of the application of their bark for tanning; and therefore directed the Secretary to make the necessary inquiries for that purpose, from Mr. White; in answer to which, the following communication was received.

SIR, *Woodlands, Sept. 10th*, 1813.

I am favoured with your's, containing a number of queries, which you request me to answer, by giving an account of the formation and progress of my plantations, at this place; an undertaking I shall enter into with very great pleasure, and be equally glad if the humble production of my pen meets with the approbation of the Society, and is found

useful to the Public; but I must observe, that, after the correct description given by my late father, in two letters addressed to them, one dated January 31, 1786, which is inserted in their 5th volume; and the other August 30, 1796; it will not be in my power to make a statement of his proceedings, without being liable to repetition.

In answer to the first part of your inquiry, I must observe, that the trees, for which he was honoured from the Society with Nine Gold and Two Silver Medals, were not planted by themselves, but intermixed; which mode was adopted, from an idea, that, as different species seek their nourishment at various depths and levels, a greater number could be raised on any given surface of ground, and at the same time afford much more beauty to the eye; which, in my professional employment of laying out grounds, is a principal study. But although these trees have been scattered over the face of the plantations, the better half being composed of resinous kinds, such as larches and firs, this peculiar attention was paid to them; viz., that where the ground promised to suit any particular hard-wood tribe, it was consequently planted in greater numbers; but, first from the tyranny of the Scotch firs, and latterly that of the larches; many, where the ground was less favourable for them, have been overpowered; which it was almost impossible to prevent, from the great number planted upon an acre, some at two feet, and others at three; whereas now we find four-and-a-half feet asunder quite near enough.

Notwithstanding the reasons given for planting promiscuously, it is certainly right to consider, in a great measure, what trees are most suitable for sale in the country, as well as the quality of the ground; should the latter not be proper for oaks, which are doubly valuable, in every situation, in most of which, however rich the surface may be, or sheltered by nature, it is necessary to plant larches and firs for nurses; as deciduous trees grow much faster, when protected by the foliage of these hardy foresters, and which can afterwards be partly or wholly cut away, as may be found most conducive to the interest of the proprietor.

The surface soil, which you inquire about, is, in some parts, of a sharp sandy nature, and in others rather channelly, to the depth of four or five inches; the top inclining to a blacker mould, and the under stratum composed of a grit-stone rock.

Other places are nearly of the same description, only of better quality; and some parts in the low grounds, are furnished with a tolerable depth of earth, which the progress of the trees easily points out; for, on the bare and worst ground, nothing but larches, firs, and birches thrive; and, consequently, not only these do better on land of the same description, but also here and there others; whereas, on the last-mentioned soil, oaks, elms, ashes, beeches, &c. have shewn an inclination to grow as luxuriantly as the resinous sorts, and which are protected with the greatest care, and even the larches cut down to make way for them; but as the Scotch firs are almost exterminated, the larches are certainly the prevailing trees in my plantation.

In answer to your question, when the planting operations began here: I think it was about the year 1776, and which were completed, in a very few years afterwards.

The holes were made with a hollow spade, invented, with many other tools, by my late father, and are thus much sooner done than by the common method, and the trees also planted shallow in the ground: deep planting being the bane of great numbers.

(To be continued.)

LXIX.—BEVAN *on obviating the necessity of stopping the Foot-paths, during the Erecting or Repairing of Buildings in the Public Streets.*

DEAR SIR, *Leighton Buzzard, 17th Oct.* 1823.

HAVING occasion frequently to be in London, I have observed the great annoyance to the public, caused by the temporary erections across the foot-pavement, commonly called *hoards*, which are generally set up by builders for their convenience, during the time of building, or repairing

the fronts of, houses in the streets of London and Westminster.

If these erections were *really necessary* for such purposes, it would be useless to complain; but the accommodation of the public, in the principal streets of London, requires that such obstructions should be of as short a duration as possible, if necessary; and if the buildings can be properly built and repaired without them, or at least to the extent now used, it is very desirable they should so be done.

Having had considerable practice as a builder, I am aware of the convenience of these hoards; but, in my opinion, the convenience of the public, ought to prevail over that of the individual: and I can anticipate the objections that will be made by the builders against any supposed infringements of their customary rights. I am decidedly of opinion, that, in most cases, where the foot-path is abruptly stopped, and the passengers forced into the dirty carriage-way, there exists *no real necessity* for the practice.

A continuation of the foot-path, before houses under repair or being re-built, may be accomplished at a moderate expense, by an *enclosed passage*, of about three feet in width, having a strong top, which may be used as part of the necessary scaffolding to the building; and, if made upon proper principles, will answer for a great number of buildings in succession: this portable passage may be placed at such a distance from the front of the building, as to leave the necessary space for the workmen. In the great streets of London, there is in general very little masonry in the front of the ground-floor; and where the street is of sufficient width, to admit of a small enclosure on the outside of this portable passage, it may be allowed, as a convenience to the workmen, and for containing materials, &c.: this plan will not interfere with the free accessibility of all the upper floors.

It may be supposed, that the proposed passage, will interfere with the proper place of fixing the ladders; but in practice this supposition will be found incorrect, and in general there will be sufficient space between the said pas-

stage and front of the building, to allow for entrance of the workmen; but there may be some places where it may be necessary to obtain an entrance to the premises immediately *under* the said enclosed foot-path, into the lower floor of the building.

It may be said, by some persons, that the building act contemplates and provides for a hoard; but the hoard thereby authorized was "for the safety of all passengers passing thereby," and not, as at present is the case, for the annoyance of the passengers.

The studs and timber, constituting these enclosed passages, should be on the outside, and plain boarding within; and with sufficient strength on the top, to serve as a stage to the scaffold.

These observations are not the result of an opinion lately, or hastily formed, but from a long and full consideration of the subject; and, although it may add a trifle to the expense of the builder, the public accommodation will be materially improved by its adoption.

I am, dear Sir, yours truly,

B. Bevan.

LXX.—MISCELLANEOUS.

*Remarks on a New Work, entitled Chemical Recreations: published at Glasgow.**

Of all the pursuits which have engaged the attention of human beings, there is none more generally applicable to the varied purposes of life, than that of Chemistry: its objects are so multifarious, that the members of every class in society stand in need, more or less, of acquiring some knowledge of its fundamental truths, to enable them to prosecute, or to improve, their different occupations; and from these considerations, we feel no small degree of satisfaction in perusing

* This work, a small 12mo., contains a series of amusing and instructive Experiments, preceded by The First Lines of Chemistry, and a minute description of a cheap and simple Apparatus; illustrated by seventy engraved Figures.

a well-digested treatise on this science: but as the most eligible means of conveying instruction are such as lie within the reach of that capacity, for whose improvement they were first designed, so it is requisite that the value or price of the materials should not exceed the ability of the individual who is willing to become a purchaser. These motives appear to have influenced the Author of the Volume now before us. Its conciseness is admirable; and a vast deal of information is arranged in a small compass, without confusion or obscurity: the most important Theories are introduced in a familiar manner, and so as to enable the Learner to appreciate their value in practice; thus giving an outline of the present state of the science, and shewing the most useful purposes to which it is applied. The Author strenuously urges the necessity for making experiments:

"It is evident, that the whole subjects of Chemistry are resolved into,—*First*, the art of performing the necessary chemical operations (that is, of making experiments)—and, *Secondly*, the obtaining, through experiments, a knowledge of the nature and properties of all natural bodies, simple and compound; so as to be enabled to apply these bodies to useful or ornamental purposes. *One experiment*, well conducted, and carefully observed by the student from first to last, will afford more knowledge, than the mere perusal of a whole volume. It may be added to this, that chemical operations are, in general, the most interesting that could possibly be devised—Reader! what more is requisite to induce you to MAKE EXPERIMENTS?"

Passing over the list of SIMPLE BODIES, to which is prefixed a small, but very comprehensive, Table, we proceed to COMPOUNDS, and select the following example:—

"*Salts.*—These are compounds of acids, in definite proportions, with alkalies, earths, and metallic oxides. They form a very numerous, and very important class of chemical bodies; and the study of their composition and properties must occupy a large share of the learner's attention. No-

thing can give such clear ideas concerning the nature of chemical changes, so well explain the laws of affinity, and exhibit to advantage the doctrine of definite proportions, as the synthesis and analysis of salts. There is another thing, also, which may be mentioned here, as it serves to shew with what facility some parts of chemical knowledge may be acquired. The student, upon being told, that the number of salts amounts to several thousands, might be terrified into the opinion, that it would be scarcely possible to remember even the *names* of so many bodies. But when he is shewn how philosophically these bodies have been arranged, and how excellently named, he will perceive, that the learning and remembering—not only their names, but their constituent principles also, is a task of but little difficulty."

To this succeeds the illustration, and then the phenomena attendant on the formation and decomposition of salts, and the descriptions of some of the most important of this class of bodies. The first part of the work closes with a short outline of mineral, vegetable, and animal substances, which, being comprised in eight pages, is perhaps rather too concise, when compared with the preceding arrangement.

The next part is, on CHEMICAL OPERATIONS and APPARATUS, with explanatory remarks on the Plates. Copious instructions are given respecting chemical vessels, and prices affixed, to enable the Student to procure or make the requisite apparatus at the least possible expense.

The experiments are arranged in Sections:—1. On the properties of Heat. 2. On Chemical Affinity. 3. On Gases. 4. On the Preparation of Salts. 5. On Tests or Re-agents. 6. Miscellaneous Experiments.—Here we shall present the Reader with some examples, chiefly taken from the last section, which is the most extensive.

"*To obtain Metallic Zinc from an Ore.*—Rub together in a mortar, one ounce of lapis calaminaris (which is an oxy-carbonate of zinc mixed with earths, &c.) and rather more

than half the quantity of powdered charcoal, mixed with a little quicklime; press a portion of this mixture into the bowl of a large tobacco-pipe, and submit it to the action of a strong clear fire; after some time, the zinc will be reduced, and will be found at the bottom of the vessel."

"*To analyse Galena, an Ore of Lead.*—A very common ore of lead is *galena*, which is a compound of lead and sulphur. It is of a blue colour, has a brilliant metallic lustre, and is easily broken. Before the blow-pipe it decrepitates, melts with a sulphureous smell, and yields a globule of lead. —Let a quantity of this mineral (say 200 grains) be pounded, and put into nitric acid, diluted with an equal weight of water. Nitrate of lead will be formed, and the sulphur will remain undissolved. Filter the solution, and crystallize the salt by evaporation. Or, add to the solution, concentrated sulphuric acid: a white precipitate of sulphate of lead will be thrown down; weigh this, and from the weight deduct 70 per cent.; which shews the quantity of lead."

"*To make Brass.*—Put into the bowl of a large tobacco-pipe, a portion of copper filings, mixed with about twice its quantity of finely-granulated zinc; cover it with charcoal-powder, and press it well together; then expose it to the action of a clear fire for some time;—the two metals will combine and form brass."

"*An example of the mode of analyzing a metallic alloy.*—Suppose the alloy to contain, silver, zinc, lead, and bismuth.—Process 1. Let it be dissolved by the aid of heat, in an excess of nitric acid.—2. Evaporate the solution to dryness.—3. Pour water on the residuum, which, of course, contains *nitrates* of the different metals—solutions of nitrate of silver, zinc, and lead, will be obtained; the nitrate of bismuth will be decomposed by the water, and oxide of bismuth (for every 100 grains of which reckon 90 grains of metallic bismuth) will be left at the bottom.—4. Into a hot, and pretty dilute solution of the remaining salts, pour muriatic acid, muriate of silver (containing 83 grains of metal in every 100 grains of the salt) will be precipitated.—5. Add

to the solution, having separated the product of the last process by filtration, sulphate of soda:—this will throw down sulphate of lead (which contains 69 grains per cent. of the metal). 6. Finally, add carbonate of potash to precipitate the zinc.—*Note.* The papers through which the mixture is filtered, are to be carefully weighed before they are used; and are to be weighed again when perfectly dry, after the process, with the pecipitates upon them. The number of grains shews the weight of the precipitates."

"*Tincture of Red Cabbage.*—To prepare this, pour boiling water upon sliced red cabbage, decant the clear infusion (which will be of a fine blue colour) when cold, and mix it with an eighth part of alcohol. Red cabbage leaves may be preserved for a long time, by drying them in a warm place till they are crisp, having previously cut them into small pieces. It is necessary to be provided with some of these dried leaves, because the tincture spoils by keeping. The blue colour of this test is changed to red by acids, and to green by alkalies and alkaline earths."

"*A beautiful green liquid produced, by mixing a blue one with a colourless one.*—Nearly fill a test-glass with water, and add to it a spoonful of the tincture of red cabbage. The mixture will be of a fine blue colour: add, next, a few drops of colourless liquid ammonia; the mixture will instantly become green. *Rationale.*—This experiment is designed to exhibit one of the distinguishing properties of alkalies, namely, that of changing vegetable colours. A solution of potash or soda produces the same effect as liquid ammonia, but, if the liquid made green by ammonia be boiled, it regains its blue colour; because that alkali, being volatile, is driven off in the gaseous state by the heat.'

"*Instantaneous production of Curds and Whey from Milk.*—A very ready and elegant mode of procuring curds, and also a pleasant acidulous whey, is, by adding to a glassful of milk a little solution of citric acid—taking care not to add too much; an experiment or two will readily shew the quantity necessary to effect the purpose."

"*To make cinders, or little wicker baskets, appear as if they were crystallized.*—Saturate water, *kept boiling*, with alum; then set the solution in a cool place, suspending in it, by a hair, or fine silk thread, a cinder, a sprig of a plant, or any other small article; as the solution cools, a beautiful crystallization of the salt takes place upon the cinder, &c., which resembles specimens of mineralogical spars."

To the experiments is subjoined, a Table of References to Tests, from which the Learner may derive considerable profit; and the Volume is completed by an Appendix, containing A Table of Chemical Decompositions—of Freezing Mixtures—and of Specific Gravities; with a List of Chemical Preparations which the Student should be provided with, to enable him to perform the experiments; and Small Articles of Apparatus.

We now conclude our observations on this work.—There are a few typographical errors, and a trifling omission in one of the plates; but these can be easily rectified, and are of small consideration, when compared with the multiplicity of excellent instruction it contains: and every Student who feels interested in Natural Science, and is desirous of acquiring a knowledge of the most valuable facts in Chemistry, may here obtain a clear elucidation of the most important principles, and have his wishes gratified at a very moderate price.

Additional Notice, On the Advantages of Mr. SPILSBURY'S *Improvements in Tanning Leather.*

WE briefly noticed, in our last number, Mr. Spilsbury's most valuable improvements in Tanning; and we were in hopes it would have been in our power to have laid before our Readers the particulars of a process, which, to every person connected with the tanning business, must be of the utmost importance.—Particular circumstances have, however, prevented this; and we must, therefore, content our-

selves, with merely giving those general remarks, which may be sufficient to convince our Readers of the importance and value of the subject before us.

Mr. Spilsbury appears to have founded his experiments on acknowledged facts; but which, nevertheless, are but little known.

It is proved, beyond a doubt, that any two liquids of the same specific gravity, will, without agitation, be a very considerable period indeed in uniting; for their natural affinity is so slight, that *even years might elapse before a mixture of them took place.*—We may consider this fact as the foundation of Mr. Spilsbury's invention. He appears to have looked more to *the cause why the process of tanning is so tedious,* than to the discovery of any new chemical process to expedite it; and he has succeeded.

In the usual process of tanning, the aqueous matter contained in the skins or hides, he proves to be the preventative to the introduction of the tanning liquor. For instance, supposing a hide or skin to be immersed, as usual, in the tan-pit; in the course of a short time, it becomes perfectly saturated: let it then be taken out, and immersed in a still stronger liquor. It is obvious, that the aqueous matter which it contained previous to the second immersion, opposes any further entrance of the tanning liquor, except, by the natural affinity of the *tan* and the aqueous matter.

What we have here stated will give our readers a tolerable idea of the correctness of Mr. Spilsbury's principle; and we intend laying before them, the specification of the Patent itself, in our next Number. We do not, however, hesitate to say, *so important is this discovery, that by it, hides of considerable density and thickness, may be thoroughly tanned in from ten to twenty days' time, and skins in three days!* At the same time, giving equal, if not greater, weight to the leather; and certainly increasing its strength, by doing away with that decomposition, which all substances must be liable to, from so long an exposure to the action of a liquid, as leather is, in the common process of tanning it.

LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal since Oct. 9, 1823.

To John Christie, of Mark Lane, in the city of London, Merchant; and Thomas Harper, of Tamworth, in the county of Stafford, Merchant; for their improved method of combining and using Fuel in Stoves, Furnaces, Boilers, and Steam Engines. Dated Oct. 9, 1823.—To be specified in two months.

To Joseph Rogerson Cotter, of Castle Magnor, near Mallow, in the county of Cork, Clerk; for certain improvements on Wind Musical Instruments. Dated Oct. 9, 1823. —In six months.

To John Henfrey, of Little Henry Street, Waterloo Road, in the County of Surrey, Engineer; and Augustus Applegarth, of Duke Street, Stamford Street, Blackfriars, in the County of Surrey, Printer; for certain Machinery for casting Types. Dated Oct. 9, 1823.—In four months.

To Edward Schmidt Swaine, of Bucklersbury, in the city of London, Merchant; in consequence of a communication made to him, by Frederick Adolphus Augustus Struve, of the city of Dresden, Doctor of Physic; and Edward Swaine, of the city of Leipzig, Merchant; for a method of producing and preserving artificial Mineral Waters, and for Machinery to effect the same. Dated Oct. 9, 1823.—In six months.

To Sir William Congreve, of Cecil Street, Strand, in the county of Middlesex, Baronet; for various Improvements in Fire-Works. Dated Oct. 16, 1823.—In six months.

To Archibald Buchanan, of Cathrine Cotton Works; one of the Partners of the House of James Finlay and Co., Merchants, in Glasgow; for an improvement in the construction of Weaving Looms, impelled by Machinery; whereby a greater quantity of Cotton may be woven in a given time, without injury to the fabric, than by any application of power for that purpose heretofore employed. Dated Oct. 16, 1823.—In two months.

THE

TECHNICAL REPOSITORY.

LXXI.—*Specification of the Patent granted to* FRANCIS GYBBON SPILSBURY, *of Walsall, in the County of Stafford, for certain Improvements in Tanning.—Dated April 22,* 1823.

I, THE said Francis Gybbon Spilsbury, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained in and by the Drawing hereunto annexed, and the following description thereof: that is to say, My improved method of tanning skins or hides consists in the application of mechanical force, by means of certain machines or apparatus, for the purpose of driving the tan-liquor or liquors through the skins or hides intended to be tanned.

The skins or hides, in the usual method of tanning, after they have been prepared by liming or other well-known processes, are immersed in the tan-liquor or liquors. In this situation, they absorb, or are penetrated by, a portion of the liquor in which they are immersed. This portion having produced on the skin or hide its tanning effect, becomes more or less exhausted; and, as long as it remains in the skin or hide, greatly retards the entrance therein of fresh portions of unexhausted tan-liquor, and thus protracts, to a very inconvenient length, the tanning process, especially when applied to dense skins or hides.

My invention consists, in the introduction of the tan-liquors, by means of mechanical force, into the pores or substance of the skin or hide; which I effect in the follow-

ing manner.—The skin or hide, being cleansed, and otherwise prepared, in the usual ways, for the action of the tan-liquor, is to be carefully examined; and any holes that may be found, are to be sewed, or otherwise secured, by means which are well known, so as to prevent the liquor from running through: after which, it is in a proper state to be exposed to the action of the tan-liquor, in conjunction with mechanical pressure, which I effect in the following manner.

I provide three frames, of similar shapes, made of wood, copper, or any other suitable material,—(I may mention, that the use of iron for this purpose, unless covered with a coating of paint, should be avoided; as its effect would be, to blacken the skin or hide,)—and furnished at the sides with ears or loops, for the reception of screw-bolts: the object being, by means of the outer frames, to press two skins or hides, one on each side, against the middle frame; and through an aperture in this middle frame, to introduce the tan-liquor, under pressure, into the space thus formed between the two hides;—the effect of which will be, to produce a continued filtration or percolation of the liquor; and, in consequence of which, the tanning process rapidly takes place.

The middle frame differs from the others, in having two pipes let into it at the top, and a cock let into it at the bottom.

One of the exterior frames being laid flat down, with its inner surface uppermost, a skin or hide, previously prepared as aforesaid, is laid or stretched over it; the middle frame is then laid on, taking care that the edges of the skin or hide shall be everywhere griped or nipped between the two frames: a second skin or hide, prepared as aforesaid, is then to be laid on the middle frame: and, lastly, the other exterior frame is to be laid on; care being taken that the edges of the second skin or hide shall be everywhere griped or nipped between the middle frame and the last exterior frame. The frames and skins are then to be

secured, by means of screw-bolts, entering into screwed holes, in the ears or loops. The frames are then to be raised upright: one of the pipes is to be secured to a pipe communicating with a cistern containing tan-liquor; the other pipe is to be left open, for the escape of air; and the cock at the bottom is to be closed. The cock of the pipe communicating with the cistern being opened, the liquor contained in the cistern will flow down, and will occupy the space between the two skins or hides, driving out the air. When the liquor has risen into the pipe for the escape of the air, shewing that the space is filled, its cock is to be closed; upon which the tan-liquor between the skins or hides, being subjected to hydrostatic pressure, by means of the communication with the cistern, (and which may be produced, increased, and varied, by methods well known,) will be forced through the pores or substance of the skins or hides, and will appear, in the form of dew, or small drops, on their outward surface.—The time required for completing the tanning will vary, according to the density of the skins or hides, the strength of the tan-liquor, the amount of the hydrostatic pressure, and other circumstances.

When the skins or hides are found to be tanned, they are to be removed from the frames; and their outer edges, as far as they were squeezed or nipped between the frames, must be pared off: the skins or hides are then to be dried, and prepared for market, in the usual manner.

It is not my intention to claim, under this patent, the exclusive use of the frames, screw-bolts, pipes, or any other article of apparatus herein-mentioned; or the use of any particular kind of tan-liquor, or any mode or process of preparing and of finishing the skins or hides; save and except, the application of the machines or engines herein described or set forth, or any imitation of them, for the purpose of causing tan-liquor or liquors to pass, by filtration or percolation, through skins or hides.

The apparatus herein described, for effecting this pur-

pose, is such as I have employed with success, and consider, upon the whole, to be the best: but particular local situations, or other circumstances, may render it expedient to change the shape of the frames, or their vertical position, for some other; or to inclose between the middle frames, and either of the exterior ones, two or more skins or hides, instead of the single one, as above mentioned.

The subjoined drawing, Plate XIV, is a general representation of the machines or apparatus already described, in which, Fig. 1 is a front view, and Fig. 2 is a side view. The same letters of reference indicate the same parts in each figure.—AA is one of the exterior frames.—BB is the other exterior frame.—*gg* are two hides, secured between the exterior frames and the middle frame, CC, by means of the screw-bolts, *a a a*, &c.—*f* is the cistern, containing the tan-liquor.—*e* is the pipe, through which the tan-liquor descends from the cistern into the space or cavity between the two hides; and which will vary in length, according to the amount of hydrostatic pressure intended to be given.—*b* is a short pipe, one end of which is fixed in the frame C, and the other in the pipe *e*.—*c* is the exit-pipe, through which the air escapes, when the liquor is running down through the pipe *e*.—*d* is a cock, for the purpose of discharging the liquid between the skins or hides.

LXXII.—LEWIS *on the Preparation of Silver-gilt Wire.*

[Concluded from p. 313.]

THE rolls, as well as the drawing-plates, have been often procured from France: and it has been thought that the wire received from the French rolls an additional beauty and lustre; though it does not appear that the French have any durable advantage in this respect above the English, or that the glossiness communicated by either is of any real advantage to the manufacture, for it quickly goes off. The most important point, in their preparation,

is, the giving them that perfect truth and equality of surface, which the flatting of so fine wire demands. The internal part is formed of iron; and a plate of refined steel is lapped round, and welded over the iron. Where the two ends of the steel plate meet, there is frequently an imperfection, the juncture being generally visible across the face of the roll. In rolls of great width, some curious artists have obviated the inconveniences arising from this cause, by using, instead of a broad plate, a long narrow bar of the steel, and twisting it round the roll in several circumvolutions; that the little inequalities, in hardness and solidity, happening at the junctures, might be in the direction of the ribbon that passes between the rolls, and not transverse to it. In the narrow rolls, used for the flatting of wire, a practice of this kind would be very difficult; but the same end might, perhaps, be answered, and even more effectually, by casting the steel, instead of a straight bar, into the form of a hoop or ring, of a somewhat less diameter than the size of the intended roll; then forging the hoop, on the round beak and flat of the anvil, alternately, to procure it the requisite uniformity of its parts, and the due extension; afterwards placing it in a proper mould, fixing the axis in its due position, and running into the intermediate space some cast-iron, which, from its known property of expanding, as it sets or becomes solid, will continue everywhere to fill the cavity, and irremoveably fix itself, both to the hoop and to the axis.

THE DEGREE OF EXTENSION OF GOLD, IN WIRE AND LEAF.

The vast extent to which gold is apparently stretched, in the foregoing operations, has induced several persons to make experiments, for determining its exact degree, by mensuration and weight. In an experiment of Reaumur's, forty-two square inches and three-tenths of gold-leaf weighed one grain troy; and Mr. Boyle found that fifty and seven-tenths weighed but a grain. As a cubic inch of fine gold weighs 4902 grains, the thickness of the gold

leaf, examined by the one, was the 207,355th; and of that by the other, only the 248,532d part of an inch.

Dr. Halley found, that, of superfine gilt wire, six feet weighed a grain. M. de Reaumur makes about four inches more go to the same weight; and Mr. Boyle is said, if there be no error in the numbers, to have had gilt wire much finer than any of these. Allowing six feet to make a grain, and the proportion of gold to be that commonly used by our wire-drawers, the length to which a grain of gold is extended on the wire comes to be near 352 feet.

In flatting, the wire is extended, according to M. de Reaumur, one seventh part of its length, and to the width of one ninety-sixth of an inch: in some trials I have seen made by the workmen, the extension in length appeared less, but that in breadth so much greater, that the square extension was at least equal to that assigned by Reaumur. Hence, one grain of gold is stretched, on the flatted wire, to the length of above 401 feet; to a surface of above 100 square inches; and to the thinness of the 492,090th part of an inch.

M. de Reaumur carries the extension of gold to a much greater degree. He says the wire continues gilded, when only one part of gold is used to 360 of silver; and that it may be stretched, in flatting, one fourth of its length, and to the width of one forty-eighth of an inch. In this case, a grain of gold must be extended to 2900 feet, or upwards of half a mile; and covers an area of more than 1400 square inches. He computes the thickness of the golden coat, in the thinnest parts of some gilt wire, to be no more than the fourteen-millionth part of an inch; so that it is only about a hundredth part of the thickness of gold leaf. Yet, notwithstanding this amazing tenuity, if a piece of the gilt wire be immersed in warm aqua-fortis (nitric acid), which will gradually dissolve and eat out the silver; the remaining golden coat will still hang together, and form, while the fluid prevents it from collapsing, a continuous opaque tube. To succeed in this experiment, the aqua-

fortis must not be very strong, nor the heat great; for then the acid, acting hastily and impetuously upon the silver, would disunite the particles of the gold.

Whether any other metal can be extended to an equal degree, is not yet as clear; for, as it is the great value of gold which engages the workmen to endeavour as much as possible to stretch it to the largest surface, the same efforts have not been made in regard to the less-valuable metals: to make a fair comparison, trial should be made of extending silver upon the surface of gold, in the same manner as gold is extended upon silver. It may be observed, also, that, as gold is nearly as heavy again as silver, or contains nearly double the quantity of matter under an equal volume; so, if equal weights of the two metals be stretched to equal extents, the silver will be little more than half the thinness of the gold; and conversely, if silver could be brought to equal tenuity with gold, in regard to bulk; it would, in regard to quantity of matter, be nearly of double extensibility.

APPLICATION OF GILT WIRE ON OTHER BODIES.

There are various methods of applying the gold, thus extended, to cover the surfaces of other bodies. For laces and brocades, the flatted gilt wire is spun on threads of yellow silk, approaching, as nearly as may be, to the colour of gold itself. The wire, winding off from a bobbin, twists about the thead, as it spins round; and, by means of curious machinery, too complex to be described here, a number of threads are thus twisted at once, by the turning of one wheel. The principal art consists in so regulating the motion, that the several circumvolutions of the flatted wire on each thread may just touch one another; and form, as it were, one continued covering.

It is said, that, at Milan, there is made a sort of flatted wire, gilt only on one side, which is wound upon the thread, so that only the gilt side appears; and that the preparation of this wire is kept a secret, and has been attempted in other places with little success. There is also a gilt

copper wire, made in the same manner as the gilt silver*. Savary observes, that this kind of wire, called false gold, is prepared chiefly at Nuremberg; and that the ordinances of France require it to be spun, for its distinction from the gilt silver, on flaxen or hempen threads. One of our writers takes notice, that the Chinese, instead of flatted gilt wire, use slips of gilt paper, which they both interweave in their stuffs, and twist upon silk threads: this practice he, inconsiderately, proposes as a hint to the British weaver. Whatever be the pretended beauty of the stuffs of this kind of manufacture, it is obvious that they must want durability: the Chinese themselves, according to Du Halde's account, sensible of this imperfection, scarcely use them any otherwise than in tapestries, and such other ornaments as are not intended to be much worn, or exposed to moisture.

PURIFICATION OF GOLD, FROM PLATINA, SILVER, AND BASE METALS.

Aqua-regia (nitro-muriatic acid), in dissolving gold, leaves behind what silver the gold had been mixed with; and certain bodies, added to the solution, separate the gold from it, without being able to separate any metal besides; so that, on this principle, gold may be brought with ease, to its ultimate purity.

The gold, flatted into thin plates, or reduced into grains, is to be put into about thrice its weight of moderately strong aqua-fortis (nitric acid), and the vessel being set in a gentle heat, a little sea-salt (muriate of soda) is to be added: the dissolution will immediately begin, with a considerable effervescence; and when the action ceases, a little more sea-salt will renew it: the injection of sea-salt is to be continued, by a little at a time, till the whole of the gold appears to be dissolved: the quantity of salt requisite is generally about a third of the aqua-fortis. The clear

* It appears to us, that this wire may be made of silver; or *copper plated with gold on one side*, as it is done with plated silver; then slit into narrow strips; and be drawn, in holes of a corresponding form, like the watch-pendulum-spring wire, till it becomes small enough to be finally flattened between the rolls.—EDITOR.

part of the solution is to be poured off, and the remainder passed through a double filter of paper: the undissolved matter is to be washed two or three times with water in the filter, and this liquor poured to the rest.

For recovering the gold from the solution, Cramer directs two methods;—distilling off the menstruum, and precipitating the gold by mercury. But, in either of these ways, we cannot be certain of having the gold pure: for, though it has been previously cupelled with lead; yet, if it contained any platina, it will retain the whole of the platina after cupellation; and, in some circumstances, it will retain also a little copper: both the platina and copper will dissolve with it in aqua-regia (nitro-muriatic acid); mercury will precipitate the platina along with the gold; and the abstraction of the menstruum will leave with it both the platina and copper.

The purity of the gold is secured by precipitation with common green vitriol (sulphate of iron).—The vitriol is to be dissolved in cold water; the solution passed through a filter, and added, in large quantity, to the solution of gold: the quantity of vitriol, before its dissolution, should be ten or twelve times greater than that of the gold. As the precipitate falls slowly, the mixture is to be set by for twenty-four hours, or more: the liquor, then become clear, though of a deep colour, is to be poured off; the brownish powder at the bottom, boiled in a little aqua-fortis; then washed with water, and melted, with the addition of a little nitre.

Gold, thus purified, appears to be perfectly fine; a point not obtainable by any other known means that can be practised in the way of business. Nor does the process seem to be so expensive as the imperfect one, by aqua-fortis (or *parting*); for there, three parts, or more, of silver, being added to one of gold, at least six parts of aqua-fortis are required for dissolving the silver; whereas the gold, in the above process, may be dissolved by half that quantity of the menstruum: great part of the acid may likewise be

recovered, by distillation, from the liquor which remains after the gold has fallen.

Kunckel is the first who has taken notice of this precipitation by vitriol: but, having used a vitriol which partook of copper as well as iron, he seems to have thought that the effect depended on the copper; and recommends the bluest and most coppery of the common sorts of vitriol, as the best: accordingly, most of those who have mentioned this process, direct blue vitriol (sulphate of copper,) or vitriol of copper. I have not found that blue vitriol produces the least precipitation in a solution of gold; so that, by this misapprehension, in regard to the nature of the precipitant, Kunckel's discovery was rendered useless, till Brandt happily observed that *green* vitriol produces the effect which had been ascribed to the *blue*.

LXXIII.—*Additional Observations on the Substitution of Fulminating Mercury, in place of the Detonating Compositions into which Chlorine of Potass enters, as a Priming for Percussion-Guns. By Mr.* E. G. WRIGHT, *of Hereford.**

SIR, *Hereford, Nov.* 15, 1823.

I FEEL obliged by the notice with which you have honoured my communication on the use of Fulminating Mercury, as a percussion-powder for guns. I beg to state, in reply to the judicious remarks which you have made, that every sportsman and gun-maker will inform you that the percussion-powder prepared with the chlorate of potass does create rust, to a degree almost exceeding belief by those who have not practically witnessed its effects, both in the chamber, the lock, and on the breech of the gun; and the dirt, generated by the charcoal, after the decomposition from the percussion, in Forsyth's and other magazine locks, is a serious inconvenience. I am aware that the prepared caps are made water-proof; but the powder for magazine locks cannot have this advantage, and, from the nature of

* See our last Number, p. 313.

its composition, it is particularly subject to be affected by moisture. Besides, many sportsmen, residing in the country, like to prepare the caps they use.

The fulminating mercury is, of course, obnoxious to explode from certain causes; and so is the chlorate of potass preparation and gunpowder: but all these compositions require care, in proportion to the danger to be apprehended from them; and I think neither the common percussion-powder, nor the fulminating mercury, ought to be kept in large quantities, but divided in portions of not more than half an ounce each; and preserved in bottles, containing such proportions, for sale or use. From experiments made by several friends and myself, it is almost certain that fulminating mercury requires *greater force*, or a *harder blow*, to inflame it, than the other powder does; and, not being liable to *spontaneous* explosion, which the mixture of chlorate of potass and sulphur undoubtedly is, forms one material recommendation, as to its superior safety. Its initial force, I know, is infinitely greater than gunpowder; but the experiment you mention with the cannon, proves, that in case of the accidental explosion of a quantity of it, though a room, and all within reach of its power, may suffer, still it could not *blow up a house or building;* as occurred lately at Birmingham, from an accident with the chlorate of potass powder. It is only intended to be used as a *prime* for caps or magazines, and is not applicable otherwise.

I perfectly agree with you as to condensing the nitrous ether, in the second process; which would render the powder, ultimately, so moderate in price, as to be attainable for general use. I have kept some fulminating mercury by me, prepared by myself, more than nine months, in a bottle, without any precaution, and do not find it has undergone the least change; neither do I think it will: though it certainly is best to keep it from the sun, and not expose it unnecessarily to the light; in short, to treat it in all respects with the same care as the common percussion-powder, and there will be little to apprehend

from accident. I conceive there is a general misconception as to the nature of fulminating mercury, which experiment will remove: from every severe test I have given it, I do not think it so very liable to explode as many imagine; indeed, quite otherwise: and every sportsman in this vicinity, who has tried it, gives it a decided preference to the common powder; so much so, that the only difficulty at present complained of, is, that it cannot be procured in the shops. I suspect it will be found to wear the *nipples*, on which the caps are placed, faster than the common powder; but this is a trifling objection to the sportsman, and not a very bad fault for the gun-maker; though even this may be obviated, by constructing the interior of the nipple of platina. For the rest, a fair trial in the field will satisfy every sportsman and gun-maker of its superiority.

I am, Sir, your obliged servant,

T. GILL, *Esq.* E. G. WARNER.

LXXIV. *On the Weight and Utility of Thatch.* *By* B. BEVAN, *Esq. Civil Engineer.*

DEAR SIR, *Leighton Buzzard, 15th Nov.* 1823.

THATCHING, with straw, has been the general covering of buildings in many parts of the country; and, in several districts, remains so at this time. Although the use of slates and tiles be preferred in towns, on account of the risk from fire, yet, in detached situations, and places where tiles and slates cannot be readily procured, thatch will still be used in large quantities.

In many respects, thatch is preferable to either slates or tiles, from its quality of being a bad conductor of heat and cold, and, consequently, preserving a more steady and uniform temperature than any other covering. Buildings covered with good thatch are warmer in winter, and cooler in summer, than those covered with other materials.

The appearance of thatch, when neatly executed, is not unpleasant; and its durability has been known to be from

twenty to thirty years. The *weight*, also, and the lightness of the requisite timbers in the roof, render it an eligible material for an economical building. The information to be obtained from our common practical books on the art of building being very unsatisfactory, although less so than from some professed thatchers of long practice, I took the pains to ascertain the weight, *per square*, when applied at the usual thickness of twelve inches; and found it to be as follows:—

Unbroken wheat-straw, clear of heads - -	500 *lbs.*
Clean, and part bruised - - - - - - -	600
Bruised, with heads - - - - - - - - -	650
Haulm, or wheat-stubble, a little moist - -	685

I am, Dear Sir, your obedient servant,

B. BEVAN.

T. GILL, *Esq.*

LXXV.—*On the Application of Larch Bark to answer all the Purposes of Oak Bark, in Tanning Leather; and on the Cultivation of the Larch. By* THOMAS WHITE, *Esq., of Woodlands, Durham.*

(Concluded from p. 351.)

PARTICULAR attention was also paid to their roots; which if fibrous and vigorous, the fine appearance of the tops was of little consequence; and therefore the heights of the trees were chosen to suit the exposure, as well as quality of the soil. But, notwithstanding the length of time that planting has been practised, scarcely one person in ten, in my humble opinion, puts in trees small enough; being anxious to gratify the eye with a sight of the tops, without considering, that perhaps, if of the hard-wood species, they will make little or no progress, till cut down, and allowed to spring up again.

So very different were those planted here, that a party of neighbouring people, after visiting the place and riding through the plantations, began to inquire where they were;

never supposing that the little pigmies under their horses' feet were trees, and would raise towering heads to the height they have already attained.

As this plan succeeded so well on my estate at Woodlands, it has been strongly recommended by us to those employers who only took our advice in the decoration of their grounds, but planted for themselves: and in all our planting contracts, the whole of which amount nearly to 5000 acres, we never deviated from the mode above alluded to, and the rules which I shall mention in some other parts of this Letter.

Many reasons are given for planting trees large out of a nursery; but I scarcely ever saw a spot that I thought was not better adapted to a tree of ten, twelve, or eighteen inches high, than above those sizes: there are, however, situations, such as old woods, and very sheltered places, where oaks and some other trees may be used, three, four, or even five feet high; but such ought to be removed, in a nursery, two or three times, to create roots equal to the length of lever above, prior to being planted in the places alluded to.

As, in exposed situations particularly, the deciduous kinds of forest-trees will not get up without the aid of nurses, such as larches and firs; these should be planted smaller than the objects they are to protect, particularly Scotch-firs, not only to enable them to bear the winds that may annoy them in the infant years, but also on account of their roots not being so well furnished with fibres. The ages of the Scotch-firs, therefore, should be only one year transplanted, viz. three years old; larches and spruce-firs, three and four years; and the hard-wood kinds, three, four, and five years old, just to suit the situations which they are to be removed to, and the progress they have made in the nursery; always keeping in mind, that the smaller the trees, the sooner they will get footing in the ground, and shoot up.

In land of a poor quality, such as mine, the kinds of

trees, proper to be first planted, may be as follow; viz., larches one fourth, Scotch-firs the same, and the rest of the ground filled up with birches, alders, oaks, ashes, and elms, in such proportions as the ground may direct, by being of a moist or dry quality, &c.

I must now beg leave to mention, that a practice prevails very much, in good soils, of cutting the grass in plantations, either for some needy cottager's cow, or from an idea of its hurting the trees; which method I always oppose with all my might; being fully of opinion, that trees, in an infant state, receive great benefit from the shelter; and that infinitely more are destroyed by the hook, than by the weight of grass lying upon them, which will, in general, only injure a few larches and firs, where it is coarse, and the land wet for want of draining.

In answer to that part of your Letter relative to the propriety of cultivating ground, before planting, by trenching, digging, or ploughing; I must say, that it certainly has a good effect to follow some of those schemes, on clayey bottoms, or in such ground as inclines thereto; and it is a farther advantage, to keep it pretty clear after being planted, by introducing amongst the trees a crop of potatoes, and hoeing it for two years after: but all this latter treatment is supposed to be in the most ornamental parts of pleasure-grounds, and probably on land of no very great extent. But with respect to such a subject as mine, I am pretty certain, so much expense in digging or ploughing may be saved, and the trees thrive equally well; as I see no progress that they have made where the ground was ploughed, more than in that which was planted in its natural state amongst the wild native heath; and although several acres were trenched, I think the principal advantage which the trees have gained, is, in part, owing to the superior goodness and depth of soil where such trenching has taken place, and from being made sheltered. But, notwithstanding what I have advanced, I have seen, particularly in the north of Scotland, very bad land that would receive

infinite benefit if it was ploughed or trenched so deep, as to perforate a close stratum of hard substance so retentive, as to hold water like a dish, and which, if not broken, will never permit the roots of the trees to descend below it; consequently, for want of this precaution and necessary expenses, they are frequently blown down, long before they arrive at maturity. In general, this obdurate substance is within reach of the plough, but sometimes deeper, and runs through very large tracts of country, like any other mineral substance.

I have before mentioned, that all the trees were planted here in holes made with a hollow spade: but larches and firs are often put in, by other persons, by making two slits with the common spade, so as to form two sides of a square, and, after lifting up the sod, which of course is fast on the other two sides, treading it down upon the plant: this is much sooner done than by digging holes; and in very light and sandy soils, where it is an advantage to disturb the surface as little as possible, this method does very well.

I am happy to have it in my power to answer your Letter relative to the value of the wood when cut down; by stating, that last year I took an under-rated average of the growing timber; which made each acre to contain 480 trees, and each tree one cubic foot and three-quarters of wood; the value of which, at the low price of two shillings per foot, would amount to 84*l.* sterling an acre, exclusive of the bark, which, at the present price of eleven guineas per ton, is equal to a third part of the timber, supposing the trees were all larches. In this estimation, some of them did not contain above one foot, whilst others measured eight, ten, and twelve feet, and which are growing upon land that only cost one and two guineas an acre: and in order to find out pretty correctly the progress that larch-trees make, which we formerly thought would double their size every eight years; I selected six, which were from fifty to sixty feet high, and measured the contents by the circles each year's growth produces; and the following was the result.

At ten years old, every tree was supposed to consist of

one part; at thirteen years and a half, the average area of each section was twice as much; at eighteen years, four times as much; at twenty-five years and one quarter, eight times as much; and at thirty years old, when they were cut down, twelve times as much as at ten years old; which therefore doubled their growth every six years. And six other trees I took an account of at Lindertis, in the county of Angus, (whilst employed there a year ago, in my profession of laying-out grounds,) and which grew upon much better soil than mine, measured as follows; viz. from ten to thirteen years and one quarter, they were twice the size; at eighteen years and three quarters, four times as much; at twenty-five years and three quarters, eight times as much; and at thirty-three years and one quarter, when cut down, they were twelve times as large as at ten years old: so that in twenty-three years and one quarter they doubled themselves three times and one half; viz. every six years and three quarters. And in order to shew how very correctly this mode of calculation agrees with the measurement of living trees, I have, for some years back, kept an account of several larches, which I numbered for the purpose, taking the girth at six feet from the ground; seven of which trees, in the winter 1809, contained 17 ft. 2 in. 6 eighths; and at the end of the two following years, their measurement was 22 ft. 11 in. 9 eighths; since which period they and several others have increased pretty much about the same ratio; but as the said trees are every year adding to their height, the increase is evidently more than what I have stated.—From the best information I can obtain to the inquiry you make about the elevation of Woodlands above the sea, and the distance from it; the former is six hundred feet, and the latter twenty miles.

In regard to the question you ask, About what time these plantations were first thinned? I think it would probably happen ten years after planting; but this business always depends upon the progress of the trees, which in sheltered situations will require the axe sooner: and the true guide

to ascertain the number to be taken out each time, is, to free every tree that is to remain from the lashes of its neighbour's tops; weeding out the worst first, and always keeping in mind which trees are to stand ultimately.

In a country where hedge-stakes are wanting, or fuel scarce, which this work consists of, the expense will nearly be paid.

The second thinning took place about eight or ten years after, or at eighteen years' growth, being as soon as the trees began to touch each other again; which produce was found useful for coal-baskets, pit-props, and crate-wood, as used in glass-houses, besides being of service for many purposes in the lead-mines, &c. &c.: this, therefore, not only paid the expense, but began to make some return for the original cost of planting the trees, &c. At the end of the next six or eight years, when they began to annoy each other again by their proximity, many were large enough for buildings, in addition to the uses before alluded to: and at the next thinning, which is now going on, I sell them as rails for coal-waggons to run on, for timbering and flooring larger buildings, for fence-railing, &c.: and the larch, which, I am happy to say, rises in estimation daily, is not only used by others in the great variety of ways before mentioned, but by myself, for some works in husbandry, where ash was before resorted to; viz. for making the entire bodies of waggons, and even blocks and poles, where the greatest toughness is required to carry heavy burthens. These waggons possess both lightness and durability, and answer perfectly well. I also find the larch to remain sound in the ground, when the small-sized oak which is laid near it, and at the same time, as the bottom rail of a coal-waggon-way, is going to decay; which perfections are in wood that will attain much greater strength, as the trees increase in size.

This last thinning is supposed to leave the trees at timber distances; viz. 12, 15, and 18 feet asunder, which I think far enough to allow larches to arrive at large dimen-

sions; whose roots, when each tree is allowed sufficient room, will occupy as much extent below ground as the branches do above.

With respect to your observations about *pruning*, I see it so very often put in practice, upon hundreds of trees that ought to be cut down, and so wretchedly performed where it might be of use, that I am afraid more mischief has been done than good, by the application of it, exclusive of the large sums thrown away; which makes me almost regret that so much has been written about it. I will, however, according to your desire, copy a few observations, written by my late father, to a friend, a year or two before his death, on this subject, and that of *shelter*.

Pruning.

"Though much has been said against it, I must observe, that no planted wood can be made clear, and brought to perfection, without it; as trees properly planted and thinned will, by the room allowed, put out large branches, which, if left on, will, in a timber state, become great knots, and in the fir-tribe, in particular, will make the timber of little value, and unsuitable for many purposes. Certain it is, that this work is often performed very improperly, so as to prevent the growth of the tree, by divesting it of too many branches, and thus injuring the circulation of the sap, for which purpose the foliage of the tree is by nature intended.

"Others, in pruning, leave stumps standing out several inches from the stem, which, when cut, die of course, and will remain on the tree till its annual growth, laid on in circles, covers the whole; and when the tree arrives at timber, and is sawn up, the dead knots fall out, leaving a hole in each plank, which the workmen call dead knots: the method, therefore, which I should recommend, is, to begin to prune some little time prior to each thinning, that the woodman may see more clearly what trees are to be taken down; at which time the branches of the fir-kind will be small, and the knots consequently so; and those of the larch may be covered with a sixpence.

" To prevent dead knots, the amputation should be performed close to the stem, which will heal in a very short time.

" The subsequent prunings may keep pace with the thinnings; it being a bad mode to defer that work till the branches become large, or to do too much at one time: and regard ought always to be paid to leave a handsome top, which should be about two-thirds of the whole height.

" These prunings, as well as the tops of the trees taken down, after they have lain a year or two upon the land, completely banish the wild native heath, and bring up white clover, and other general grasses; which, added to the annual droppings of the larch and other trees, have, in the course of twenty or thirty years, a good effect, in deepening the soil, and preparing it for vegetation."

Shelter.

" This article I conceive to be of so much importance as not to be omitted, it is as essential to the growth of trees, as the soil that produces them; as the greater the mass together, the quicker they will grow, particularly in such situations where nature has not provided shelter; which must appear evident by comparing rows, clumps, and small plantations, with extensive woods of the same ages: and, as the west wind in all parts of this island is more prevalent than any other, there should be always, in that quarter, a formidable screen of the hardy resinous trees, such as firs and larches, which should be pruned no higher than the wall or hedge that surrounds them; and the article of thinning should only be so performed on that side, as to prevent their growing into poles, which would divest the wood of that shelter you wish to encourage. In short, the western border should be so managed, as to make it subservient to the good of their more-protected and prosperous neighbours: indeed, they will, by their slow growth to the west, require less pruning and thinning; for so severe is this wind upon trees, that even upon the eastern shore they lean from the west."

The orchard of eleven acres, which you mention in your Letter, I am sorry I cannot give so good an account of; for, although the trees were planted facing the south, with large masses of wood all round, as the ground sloped quickly it was rather too much exposed to the east and west winds, but particularly the latter, which came sweeping up the valley, before the forest-trees were high enough to protect them; which defect, in addition to the injury some of the fruit-trees received in our absence, from the plough, both on their bark and roots, by careless drivers; induced us to take up the best trees, and plant them, large as they were, on a smaller scale, and on a spot more level and perfectly sheltered, where they are now producing very well. But in this northern climate, where we are very liable to untoward springs, fruit-trees are often severely handled by frosts, which come on so very late, as to make the produce very precarious, and to injure very much even the tender leaf of the larch, as well as other forest-trees: it is therefore almost impossible to have an orchard too much sheltered by lofty hedges, rows of trees, &c., which are the only true ways to avoid disappointment and chagrin at the yearly loss of your fruit: as an example of the good effects of which, I know a cottager's orchard, made out of an old gravel-pit, so sheltered by hedges, bushes, and trees, as scarcely ever to fail, notwithstanding the barrenness of the soil.

Our late agent, West, whom you mention, and was a most clever active man, died twenty years ago. However, I flatter myself, that any information he could have given, relative to these plantations, I have, from my long residence on the spot, been able to detail pretty correctly.

It is with very great pleasure, indeed, that I answer your question, Whether the bark of the larch continues in favour with the tanners? one of whom, a customer of mine, who deals very extensively in the trade, has not, I believe,

used much oak-bark this season, and probably will not, should the supply of larch be sufficiently abundant. He finds such advantage in the beautiful light colour of the leather, as well as in the process being shortened by the larch tanning quicker than the oak-bark; that I think his neighbours, in another year, will try to have a greater share in the advantage of using this substitute.

I take every method of trying leather tanned with it; and it has never once induced me to have a worse opinion of it than I at first entertained.

At the time I began tanning with larch-bark, I tried Spruce and Scotch fir, Weymouth-pine, and some other barks, all which I found would tan in a certain degree, but which were of very little comparative value with the larch: and as I supposed the weakness of the fir-tribe, in its timber, would be rendered still more so by taking off the bark; I have lately had an opportunity of proving it, and see that one year after, if the wood is exposed to the weather, it is perfectly unfit for any purpose but the fire, by shewing evident signs of decay; but, notwithstanding this great defect, as my first experiment in tanning with fir-bark was only very limited, I was determined, on being requested by Mr. Stobbort, of Hexham, to try it, to do so on a larger scale against larch-bark; which, at first, appeared to advance pretty equally; but I now find the leather in the larch-pit perfectly done, and that in the other will require as much more time, besides almost double the quantity of bark. As I mention the tanning quality of fir-bark, I must also give a comparative statement of the expense of collecting it. Each Scotch fir affords little more than half the quantity of larch of the same dimensions, and takes nearly double the time in peeling, which brings the expense to be almost fourfold that of the larch: as that is the case, and almost double the quantity of bark is necessary to tan the same weight of leather, it can only be an object to be resorted to on the greatest emergency, when little or nothing else can be got, and where it can be collected from

wood that is only wanted for firing; as no prudent person would think of destroying his timber for the scanty supply of bark which a fir will afford.

The eleven guineas per ton, which I received last year for larch-bark, I only demand this, in order to encourage the use of it; but its true value, many farmers have now the candour to say, is little inferior to oak bark.

Before I conclude this subject, I must beg leave to add, that, notwithstanding the great extent of plantations made within fifty years in Great Britain; unless the proprietors of land turn their attention to their increase, by filling with trees every part not convertible to useful tillage, the produce of bark will do away the necessity of importation; as it requires such a surface of ground to go over, to meet the yearly consumption, as is almost incredible.

And it is a matter of great regret, that, within the period mentioned, numbers of them are going fast to decay, from a want of being thinned soon enough, and in a proper manner; which no planter now can have an excuse for neglecting, when the tanner holds out to him, in almost every town, a sure return for his trouble and expense; in addition to the incalculable advantage of permitting the remaining trees to double themselves in value every six or eight years, which they can only do by a liberal use of the axe.

I am, Sir,

Your most obedient,

humble Servant,

THOMAS WHITE.

To C. TAYLOR, *M.D. Sec.*

LXXVI.—*On encouraging an extended Growth of Potatoes; on the Manufacture of Farina or Flour from them; and on applying it to make Sea-Biscuits, Bread, Pastry, &c. By* JOHN WHATELY, *Esq.*

(Concluded from p. 326.)

EXPERIMENTS ON BREAD.

FIRST EXPERIMENT.

No.	Weight. lb.	oz.	Materials.	Pr. d.	Amount. s.	d.	Weight of Bread. lb.	oz.	Cost. per lb. d.	Observations.
1.	2	8	Flour	5¼	1	1⅛	3	6	3⅞	Good bread.
2.	2	0	Flour	5¼	0	10½	2	11	3⅞	The same.
3.	1	8	Flour	5¼	0	7⅞				
	1	0	Farina	3	0	3				
	2	8			0	10⅞	3	4	3	Raw-potatoe flavour.
4.	2	0	Flour	5¼	0	10½				
	1	0	Farina	3	0	3				
	3	0			1	1½	3	13	3½	The same.
5.	1	8	Flour	5¼	0	7⅞				
	2	0	Farina	3	0	6				
	2	0	Boiled Pota.	½	0	1				
	5	8			1	2⅞	5	7	2¾	Slight flavour of the raw-potatoe; crust soft.
6.	1	8	Flour	5¼	0	7⅞				
	1	0	Boiled Pota.	½	0	0½				
	2	8			0	8⅜	2	9	3½	Well-tasted bread; moist.
7.	2	0	Flour	5¼	0	10½				
	1	0	Boiled Pota.	½	0	0½				
	3	0			0	11	3	0	3⅝	The same.
8.	1	0	Flour	5¼	0	5¼				
	1	0	Farina	3	0	3				
	1	0	Boiled Pota.	½	0	0½				
	3	0			0	8¾	3	2	2¾	Excellent bread. I consider it fully as satisfying as bread made wholly of wheaten flour.
9.	1	0	Flour	5¼	0	5¼				
	1	0	Boiled Pota.	½	0	0½				
	2	0			0	5¾	1	13	3⅛	Baked heavy, but very sweet bread; moist.

SECOND EXPERIMENT.

No.	Weight. lb.	oz.	Materials.	Pr. d.	Amount. s.	d.	Weight of Bread. lb.	oz.	Cost. per lb. d.	Observations.
1.	2	0	Flour	$5\frac{1}{4}$	0	$10\frac{1}{2}$				
	1	0	Boiled Pota.	$\frac{1}{2}$	0	$0\frac{1}{2}$				
	3	0			0	11	2	$15\frac{1}{2}$	$3\frac{3}{4}$	Baked heavy, but not unpleasant bread.
2.	1	8	Flour	$5\frac{1}{4}$	0	$7\frac{7}{8}$				
	2	0	Farina	3	0	6				
	2	0	Boiled Pota.	$\frac{1}{2}$	0	1				
	5	8			1	$2\frac{7}{8}$	5	6	$2\frac{3}{4}$	Baked heavy; indifferent bread.
3.	2	0	Flour	$5\frac{1}{4}$	0	$10\frac{1}{2}$				
	2	0	Farina	3	0	6				
	2	0	Boiled Pota.	$\frac{1}{2}$	0	1				
	6	0			1	$5\frac{1}{2}$	6	0	$2\frac{7}{8}$	Excellent bread; improved by being kept a few days, rather overbaked.
4.	1	8	Flour	$5\frac{1}{4}$	0	$7\frac{7}{8}$				
	1	0	Farina	3	0	3				
	1	0	Boiled Pota.	$\frac{1}{2}$	0	$0\frac{1}{2}$				
	3	8			0	$11\frac{3}{8}$	3	5	$3\frac{1}{2}$	This proportion is perhaps superior to the last, but the bread of both is excellent; improved by being kept a few days.
5.	1	0	Flour	$5\frac{1}{4}$	0	$5\frac{1}{4}$				
	1	0	Farina	3	0	3				
	1	8	Boiled Pota.	$\frac{1}{2}$	0	$0\frac{3}{4}$				
	3	8			0	9	3	3	$2\frac{7}{8}$	Rather too moist, but very sweet and good, and much improved by keeping.
6.	1	0	Flour	$5\frac{1}{4}$	0	$5\frac{1}{4}$				
	1	0	Rasped Pot.	$\frac{1}{2}$	0	$0\frac{1}{2}$				
	2	0			0	$5\frac{3}{4}$	1	12	$3\frac{1}{2}$	Light pleasant bread; dark coloured

THIRD EXPERIMENT.

1.	2	0	Flour	$5\frac{1}{4}$	0	$10\frac{1}{2}$				
	2	0	Farina	3	0	6				
	2	0	Rasped Pot.	$0\frac{1}{2}$	0	1				
	6	0			1	$5\frac{1}{2}$	6	2	$2\frac{7}{8}$	Heavy; discoloured; made from potatoes rasped 48 hours; flavour not pleasant.

THIRD EXPERIMENT (continued).

No.	Weight. lb.	oz.	Materials.	Pr. d.	Amount. s.	d.	Weight of Bread. lb.	oz.	Cost. per lb. d.	Observations.
2.	2	0	Flour	5¼	0	10½				
	2	0	Farina	3	0	6				
	2	0	Boiled Pota.	½	0	1				
	6	0			1	5½	6	1	2⅞	Heavy.
3.	1	8	Flour	5¼	0	7⅞				
	1	0	Farina	3	0	3				
	1	0	Rasped Pot.	½	0	0½				
	3	8			0	11⅜	3	9	3¼	Rather heavy: discoloured. The boiled potatoes are evidently a more desirable ingredient than the rasped.
4.	1	8	Flour	5¼	0	7⅞				
	1	0	Farina	4	0	3				
	1	0	Boiled Pota.	½	0	0½				
	3	8			0	11⅜	3	5	3½	Good bread; toasts extremely well: indeed all bread made of a proportion of potatoes is remarkably good tasted.
5.	2	0	Flour	5¼	0	10½				
	1	0	Farina	3	0	3				
	1	0	Rasped Pot.	½	0	0½				
	4	0			1	2	4	0	3½	Rather heavy; discoloured; flavour not good.
6.	2	0	Flour	5¼	0	10½				
	1	0	Farina	3	0	3				
	1	0	Boiled Pota.	½	0	0½				
	4	0			1	2	4	0	3½	Excellent bread; superior in colour to No. 4, and rather more compact; this quantity of wheaten flour alone, as appears by No. 7, would have produced 2lb. 10 oz. of bread; consequently, the actual proportion of the produce of the potatoe, in this loaf, is 1 1lb. 6 oz., or, as nearly as possible, one third.
7.	2	0	Flour	5¼	0	10½	2	10	4	Rather dark: the appearance of this loaf indicated that the yeast used for this batch was not good.
8.	2	0	Flour	5¼	0	10½	3	4	3¾	Excellent bread; whiter than bread made of wheaten flour alone: no flavour whatever of potatoe: not used until 9 days old.
	0	8	Farina	3	0	1½				
	2	8			1	0				

THIRD EXPERIMENT (continued).

No.	Weight. lb.	oz.	Materials.	Pr. d.	Amount. s.	d.	Wright of Bread. lb.	oz.	Cost. per lb. d.	Observations.
9.	2	0	Flour	5¼	0	10½				
	0	8	Farina	3	0	1½				
	0	8	Rasped Pot.	½	0	0¼				
	3	0			1	0¼	3	7	3½	Not equal to No. 10, an additional proof that rasped potatoes are not desirable.
10	2	0	Flour	5¼	0	10½				
	0	8	Farina	3	0	1½				
	0	8	Boiled Pota.	½	0	0¼				
	3	0			1	0¼	3	5	3¾	Excellent bread; rises by toasting; and was quite fresh at 7 days old.

From these experiments, it appears that various proportions of potatoes and farina are highly palatable in bread; but, if it be calculated that not more than one-fifth part be generally introduced into consumption, the operation of that fifth is sufficiently great to produce all the effects in view, in recommending its general adoption.

Some kinds of potatoes contain a much greater proportion of farina than others, some yielding a seventh part, and even a still larger proportion of it. Experience will best determine the most desirable sort for use. As other kinds produce more abundantly in number, all these considerations should be attended to.

Potatoes may be manufactured into farina during the greater part of the year, but they lose a portion of their farinaceous matter when vegetation begins: the manufacturer, therefore, should provide an early sort, to commence his operations upon in August, and cease to grind any after the months of April and May.

Frost-bitten potatoes yield nearly as good farina as the others, provided they are ground before they begin to decay; and potatoes kept over for a whole season, although of inferior value, may, by this process, be still rendered serviceable food for mankind. These are advantages which

ought not to escape notice. Frost-bitten potatoes have hitherto become, in a short time, a total loss; and farmers have generally been afraid of extending their cultivation of potatoes, for fear of their being spoiled by keeping, both which inconveniences are avoided by preparing the farina from them.

Amongst the many important uses to which the farina may be applied, that of biscuit for sea-store is of great consequence. Biscuits made from one part farina and two parts of wheaten flour are whiter and better than those made wholly of common flour. Baked biscuits of these proportions have been repeatedly made with uniform success; and as the farina is in itself less corruptible than wheaten flour, it is likely to produce a biscuit of a less perishable kind. Some have been already kept nearly twelve months, without exhibiting any symptoms of moisture or decay; on the contrary, they were as hard and as good as on the day they were baked. Biscuit differs from leavened bread in this circumstance, that all moisture is evaporated from biscuits in baking, whilst it constitutes an essential quality in bread; the weight of bread is greater, the weight of biscuit is less than the flour of which it is composed: it is therefore not inconsistent with the nature of farina, that it should exhibit more moisture in bread, and yet discover no symptom of it in biscuit; and it has one convenient property, of which a baker, who manufactures it, may avail himself, that it may be used for bread or biscuit either in a wet or dry state, consequently the expense of drying it may in some cases be avoided. Its introduction into biscuit would produce a saving of one-third of the wheaten flour now used for that purpose, which will be found very great, when the extensive use of biscuit in the navy and army is considered. The farina of potatoes should constitute, from its general application, a part of the stores of each.

In the navy particularly, the farina would afford a great variety of food, as it forms an excellent ingredient in soup,

as a substitute for peas, oatmeal, and rice; and possesses the superior advantage over those substances, of not being susceptible of injury. One ounce of farina will thicken sufficiently, nearly one quart of water: and when this soup is flavoured with onions, celery, leeks, &c. and seasoned with pepper and salt, it forms a very palatable mixture without the aid of meat. The produce of twenty-one pounds of raw potatoes made into farina, and soup formed from it, will furnish a wholesome meal to twenty-eight persons, allowing each person a full quart; which potatoes, in their original state, would scarcely furnish a dinner to one-third of that number.

The farina of potatoes will form a thick mucilage with twenty-six times its weight of water.

In all cases where the farina is intended to be converted into a gelatinous state, the farina should be previously mixed with some portion of the liquid, cold.

A dessert-spoonful of the farina, mixed with a little cold milk and salt, and added to a pint of boiling milk, and kept stirring and simmering, will form an excellent nutriment.

From various circumstances, it appears that the article called Semolina in the shops, and recommended as a nutritious diet for children and sick persons, is wholly composed of the farina of potatoes.

CERTIFICATES.

Mr. Whately, of Cork, has shewn me a specimen of flour made from potatoes; and also of biscuit, made partly from this flour and partly from the flour of wheat. I am convinced that this flour is very wholesome and very nourishing; and may be of great use to the public, in supplying the deficiency of wheaten flour.

Lower Grosvenor Street, Dec. 11, 1812. M. BAILLIE, M. D.

I have examined the flour from potatoes, made by Mr. John Whately, and have no doubt of its containing all the

completely immersed in water, and well stirred: the separation of the farina, by its falling to the bottom, will speedily take place. The fibrous and refuse parts should be first removed; and the farina afterwards repeatedly washed, until it no longer communicates any tinge to the water: it is then sent to the stove or drying apartment, put into boxes, and dried. Care should, however, be taken, that it does not dry too rapidly. Wherever the business is conducted upon a large scale, a machine for washing the potatoes* should be erected, and it might be contrived to receive motion from the power that actuates the grinding-machine. The vessels containing the pulp should be so arranged, that a stream of water could be made to pass through them at pleasure. The pulp, after the first separation of the farina, still retains a quantity of farinaceous matter; but it will, perhaps, be more profitable to convert it into food for hogs, with such other additions as may be thought necessary; than to steep it again for the purpose of extracting any remaining portion of farina. It will be probably best to give it to the hogs boiled, along with a moderate proportion of boiled potatoes. This disposal of the refuse pulp, would nearly defray the whole expense attendant upon the manufacture of the farina.

*** This machine would operate with good effect for reducing apples to a pulp for making cider, as it is extremely expeditious and effectual in its operation.

LXXVII.—*Description of Two Instruments, for Cutting out the Eyes of Potatoes, for Sets or Plants. Invented by Mr.* RICHARD GREEN†.

WITH FIGURES.

GENTLEMEN, *No.* 8, *Lisle-street, Leicester-square.*

I HAVE herewith submitted for your inspection, two machines, or instruments, for cutting potatoes, for sets, or

* Models of two machines proper for washing the earth from potatoes, may be seen in the Society's Repository.

† From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

seed: they are of a simple construction, differing a little from each other. Their advantages are, ease and facility in cutting the sets, and a certainty of the cuttings or sets being of a proper size, which is a matter I respectfully recommend to your notice.

The sets will be all about an inch in diameter, and can be planted by a bean-barrow, or drill-machine, with one-third of the labour, and with more accuracy than by hand. A boy and one horse will be sufficient to plant with such sets an acre in a day.—I remain, Gentlemen,

Your most obedient humble servant,

RICHARD GREEN, Ironmonger.

To the Society of Arts, &c.

Reference to the Engraving of Mr. Richard Green's Potatoe Scoops, Plate XV. *Figs.* 3, 4, & 5.

AA, fig. 2, represents the handle of the machine, nearly of its proper size; B, the shank inserted into the handle united to the semicircular cutter or knife, D, which is sharp at both edges, and turns on pivots at B and *a* in E, a brass plate, which, by means of ears or projections from it downwards, at *c c*, allows the knife D, when a potatoe is held firm in the left-hand, and the plate E pressed down hard upon it with the left-thumb, to cut from it a semicircular solid piece or set, by turning the handle with the right-hand, and forcing the knife through it in a semicircular direction.

Fig. 3, shews an end view of the brass plate, its ears, and steel cutter, supposed to have been pressed into a potatoe; D, a section of the steel cutter; and B, the end of one of the pivots on which the cutter turns.

Fig. 4, shews another machine for the same purpose, in which X is part of the handle. D, the cutter, which is here a perfect circle. *e e*, a brass ring, in the lower projections from which the cutter turns upon pivots, at *a* B, making a complete revolution in turning round the handle. E, an arched brass-piece, rising from the brass ring *e e*, on

which the pressure with the thumb of the left-hand is to be made, as in the other instrument.

The only attention necessary in the use of either instrument is, to place it so upon the potatoe, that the eye, or part from whence the shoot springs, is nearly in the centre of the piece to be cut out to set.

LXXVIII.—*On a useful Paste, made from Potatoes; for Paper-hangers, Stationers, Weavers, Bookbinders, Trunk-makers, Upholsterers, Calico-printers, &c. Invented by Mr.* CHARLES DRURY.*

SIR, *Mansfield, Notts. May* 1, 1812.

PERMIT me to lay before the Society of Arts, &c. a substitute for wheaten-flour paste. I have given it a fair trial for ten months past, in order to convince myself and others of its usefulness. From these experiments, I have no doubt it will prove equal to, if it does not surpass, that made from wheaten-flour, for the use of paper-hangers, stationers, weavers, trunk-makers, calico-printers, &c.; and also, for labels, cards, and pasteboard; as it may, with ease, be made free from lumps; and it does not permit the air to get under the paper, as in common paste, nor injure the colour of it. It is free from any offensive smell; and is not above one-third part the price of that prepared from wheaten-flour. The use of the potatoe-paste would cause a saving of many thousand bags of flour annually, which might be then applied to the nourishment of mankind.

One peck of potatoes, when prepared, will make upwards of thirty-eight pounds of paste: and one acre of land, planted with potatoes, would produce more than many acres of wheat.

* From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted the Sum of Ten Guineas to Mr. Drury, for this useful discovery.

I shall be happy to attend upon the Committee, and afford it full explanation upon the subject.—I remain, Sir,

Your most obedient humble servant,

To C. TAYLOR, *M.D. Sec.* CHARLES DRURY.

Process for preparing Mr. Drury's Paste from Potatoes.

Take one pound of raw potatoes, well washed from dirt; grate them fine, on a common tin grater, without paring them, into two and a half pints of water: then boil the whole mixture immediately, and stir it well during the whole time of boiling, which should be about two minutes; then remove it from the fire, and add to it half an ounce of finely-powdered alum, by gradually sprinkling it into the paste, and stirring it with a spoon till the whole is perfectly incorporated. It will then be fit for use, and forms a beautifully transparent paste.

Letter from Sir JOHN SINCLAIR, *Bart. President of the Board of Agriculture.*

DEAR SIR, *27, Old Burlington Street, May* 29, 1812.

This will be delivered to you by Mr. Charles Drury, whose mode of making paste seems entitled to the attention of the Society of Arts &c.—I remain, dear Sir,

Your very obedient servant,

To C. TAYLOR, *M.D. Sec.* JOHN SINCLAIR.

Certificates were received from Mr. Richard Free, Trunk-maker, 115, High Holborn; Messrs. J. Viney and Co, Trunk-makers, 122, Aldersgate-street; and Mr. F. Clark, Bookseller, 33, Piccadilly; all stating Mr. Drury's potatoe-paste to be equal to that made with flour; and that, after being made ten or twelve days, and exposed to the air, it did not appear to be in the least degree changed.

*** Mr. Whately's machine (see Plate XV.) for reducing potatoes to a pulp would be found highly advantageous to use, where a considerable quantity of potatoe-paste is made.

LXXIX.—*On a Method of Cleaning Silk, Woollen, and Cotton Goods.—By Mrs.* ANNE MORRIS.*

SIR, 41, *Union Street, Middlesex Hospital, Feb.* 4, 1805.

I BEG the Society's inspection of a method I have invented for cleaning silk, cotton, and woollen goods; which, I think, will be found very efficacious.

Your humble servant,

To C. TAYLOR, *M.D. Sec.* ANNE MORRIS.

Description of Mrs. Morris's Method.

Take raw potatoes, in the state they are taken out of the earth; wash them well; then rub them on a grater, over a vessel of clean water, to a fine pulp; pass the liquid through a coarse sieve, into another tub of clear water: let the mixture stand, till the fine white particles of the potatoes (the *fœcula*) are precipitated: then pour the *mucilaginous potatoe-liquor* from the fœcula, and preserve this liquor for use.

The article to be cleaned should be laid upon a linen cloth, on a table; and, having provided a clean sponge, dip it into the potatoe-liquor, and apply the sponge thus wet upon the article to be cleaned, and rub it well upon it, repeatedly, with fresh portions of the potatoe-liquor, till the dirt is perfectly loosened: then wash the article in clean water several times, to remove the loose dirt: it may afterwards be smoothed and dried.

Two middle-sized potatoes will be sufficient for a pint of water.

The white fœcula, which separates in making the mucilaginous liquor, will answer the purposes of *tapioca*†; will make a useful nourishing food, with soup or milk; or serve to make starch and hair-powder.

The coarse pulp, which does not pass the sieve, is of

* From Vol. XXIII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted the Sum of Fifteen Guineas to Mrs. Morris, for this Discovery.

† See the following Article.

great use in cleaning worsted or woollen curtains, tapestry, carpets, or other coarse goods.

The mucilaginous liquor of the potatoes will clean all sorts of silk, cotton, or woollen goods, without hurting the texture of the articles, or spoiling their colours.

It is also useful in cleaning oil-paintings, or furniture that is soiled.

Dirty painted wainscots may be cleaned, by wetting a sponge in the liquor, then dipping it into a little fine clean sand, and afterwards rubbing the wainscot therewith.

ANNE MORRIS.

Various experiments were made by Mrs. Morris, in the presence of a Committee, at the Society's House: the whole process was performed before them, upon fine and coarse goods, of different fabrics, to their satisfaction.

LXXX.—*On the Preparation of Tapioca from Potatoes. By the* EDITOR.

SEVERAL years since, the Editor wished to dry some potatoe-starch or fæcula, hastily, from the water it contained, after the principal part of the water had been poured off. Heat was applied to the vessel containing the starch, *when it instantly became a transparent mucilage:* upon stirring this, with a view to remove it, it agglutinated into irregular lumps, of various sizes and forms: these, being gradually dried in a moderate heat, hardened, and, in fact, formed a substance possessing all the properties of *tapioca*, and particularly its taste, and the singular property of requiring a long-continued boiling in water, milk, &c., to soften the granular concretions, and fit it for becoming food; in short, requiring exactly the same treatment as the genuine tapioca, from which it could not be distinguished.

LXXXI.—*On the Analogy between Chemical and Musical Combinations; on the Effects of Temperature on Musical Instruments; and on the Cause of the Production of Musical Tones from burning Hydrogen Gas.* *By Mr.* GOLDSWORTHY GURNEY, *Surgeon, and Lecturer in Chemistry, 7, Argyll Street, London.**

IN the chemical union which takes place between various bodies, it is observable, that they unite with each other in different proportions, but that the same bodies, or bodies of a similar composition, invariably unite with each other in the same proportion at one time as at another: in other words, it is invariably found, that certain compounds contain exactly the same relative proportions of their component parts. The theory which has been endeavoured to be established, on the facts of this kind which have already been observed, is called the *atomic theory*, or theory of definite proportions.

The student will find this part of our subject to be fraught with the highest interest, and developing the most curious and beautiful views of the ultimate laws of inorganic matter.

The laws of *definite proportions* are most obviously seen to act in the union of gaseous bodies. Some will unite in only one proportion; others in various proportions: but, whenever bodies unite in more than one proportion, it is invariably found that the second proportion, the third, &c. *are simple multiples* of the first. Oxygen and hydrogen, for example, will unite in one proportion, to constitute water. The proportion in which these substances unite, is $11\frac{1}{2}$ of the latter, by weight, to $88\frac{1}{2}$ of the former; or, in other words, the oxygen bears a proportion of $7\frac{1}{4}$ to 1 of the hydrogen. This proportion, you are to observe, refers to weight alone. In point of volume, the disproportion is, in these particular bodies, on the other side; two volumes

* From his "Course of Lectures on Chemical Science." Just published.

of hydrogen uniting themselves to one of oxygen; because oxygen is, in common language, fifteen times heavier than hydrogen. Perhaps a more clear and satisfactory explanation of this may be given, by stating, that, in compositions consisting of *one* proportion only, it is supposed that every single atom of an element A unites itself to a single atom of an element B; and that the difference of proportion results from the difference in the relative weights of these atoms. Thus, the number 1 being given, to represent the weight of an atom of hydrogen, $7\frac{1}{4}$ will be the relative weight of an atom of oxygen. The combinations of two elements in *one* proportion, are called *binary*; where they combine in *two* proportions, they are called *ternary*; in three, *quaternary*, &c. Oxygen and carbon combine in two proportions only; 100 parts of carbon uniting with $132\frac{1}{2}$ of oxygen; or with 265, which is a simple multiple of $132\frac{1}{2}$. But these substances will unite in *none* of the *intermediate proportions*; nor in none beyond the one stated. Again, the metal called manganese will unite with *four* different proportions of oxygen; 100 parts of the metal taking up either 14 parts of oxygen, 28 parts, 42 parts, or 56 parts; but in *no other proportions*. And you will observe, that the numbers which follow 14 in this statement, are the products of that number, multiplied by 2, 3, and 4. Demonstrated examples of this kind have now become so numerous, that the law of simple multiples is generally adopted, with regard to all those compounds which are observed to combine in fixed proportions only. But there are other bodies, which combine in all possible proportions, up to a certain point; and there they refuse to combine further. Thus, water will combine with any given portion of common salt, up to a certain point; and then it ceases to unite with more. This point has been called the point of *saturation*; and, on examination, it will be found that, at this point, the water has always united with a relative weight of the salt. Other bodies, again, will unite with any quantity of another body, in any proportion; as alcohol

and water, or sulphuric acid and water, &c. But it is observable, that, in these latter instances, the union is not between the ultimate atoms of the bodies, but merely between secondary combinations of them; so that these examples must not be considered as militating against the universality of the laws of definite proportions.

The theory of definite proportions, or the definite combination of ultimate atoms in fixed numbers, with respect to the elements which unite together, is now established on so firm a basis, that there are few to be found who doubt the truth of it: and the further we inquire respecting this arrangement, the more we become satisfied, that not only definite combination does exist, but that, in virtue of this definite combination, all the harmony of nature is produced; and even the most abstruse and difficult problems may be solved, by examining them with a view to these laws. In fact, the same cause, which I have presumed to govern and produce the unerring forms of *crystals*, must also produce *definite* combinations of the atoms of matter.

I fear that it will be felt tedious, if I here go into this subject minutely; so as to demonstrate that definite proportion is an *effect* of the same cause that governs crystallization: nor is it necessary for me to take up your time to do so; since any one can convince himself of the truth of these results, if he examines the effect of the operation of this law, on a simple *mixture* of elements, in *definite proportions*, without order or arrangement amongst themselves: for, presuming that our other positions are correct relative to the ultimate atoms of matter, it will be obvious that they can chemically combine only in definite numbers, with respect to each other; and that every indefinite atom must be thrown out, and be incapable of combination. So that, perhaps, it would be more correct, if I state, that "definite proportion" is the *primary* effect of this law; and that crystallization is nothing more than a modification, or a necessary result of the same.

But this unerring and harmonious effect, which we call

"definite proportion," is not the only result of those laws. For my own part, I believe their influence, in some way or other, governs the effect of all matter; and may be easily traced and demonstrated in many more branches of science than it has hitherto been considered to affect. Musical chords, for instance, or combinations of tones, on which the delightful harmony of music depends, seem to me to result entirely from the same laws as those which govern definite proportions; for, as the combinations of chemistry are governed by definite proportions of *atoms*, so the combinations of sound are governed by definite proportions of *vibrations*. As the external *forms* of crystals are produced by certain definite positions, and distances, between their component atoms, so the *sounds* resulting from the motion of certain bodies are dependent on definite positions of the particles affected by the mechanical stretchings, lengths, distances, &c. of sonorous substances.

Elements, in chemistry, combine in the proportions of one to one, one to two, one to three, &c., constituting *perfect compounds:* so, also, musical vibrations combine in the proportions of one to one, one to two, one to three, &c., constituting *perfect chords*, or concords. Substances in chemistry combine in the proportions of three to two, five to three, &c., constituting *less*-intimately-formed *compounds:* so it is, also, in regard to vibrations of sound; they combine, three to two, five to three, &c., constituting thirds, great sixths, &c., which are *less*-perfect *chords*; and so on, through the various gradations of harmony of tone.

We have, here, an obvious and most striking analogy between the laws which govern each of these compounds; for the latter may fairly be considered as *compounds*, though it is but of spaces, or vacuums, that they consist. For tone is produced by a series of detonations; and detonations are produced by the sudden formation and filling up of a series of vacuums. The one is formed by definite proportions of *atoms;* and the other, by definite proportions of *vacuums*. In the one case, we have a certain number of

spheres, producing a harmony of form, and appealing to the eye; and, in the other, a certain number of *spaces*, producing a harmony of sound, and appealing to the ear: in neither case could that *harmony* be produced by any other law, than one which produces a definite or regular and fixed number of the components. An *indefinite* number of elements, *mixing* together, would, and do produce, not regularity, but confusion; and an *indefinite* number of vibrations or spaces, *mixing* together, produce, not harmony, but *discord*. That the former is the case, I have shewn; and shall have occasion to shew again, hereafter. That the latter is the case, I could prove to a demonstration, by various experiments, if this were a fit occasion to do so. It may still, however, not be considered as impertinently out of place, if I call your attention, in illustration of what I have now advanced, to the laws which govern the monochord, the definite division of the organ-pipe, the concords on the French-horn, the Æolian-harp, &c. &c.

In all these cases, certain divisions of the strings, pipes, &c. under the same circumstances, will produce a certain number of vibrations, detonations, or intervals, in a given time. These vibrations will either combine, or not, with other vibrations, as they may happen to be definite numbers with respect to each other. The following experiment may be made. Take a long string, and stretch it against a wall, so as to vibrate freely: now, slightly put it in motion; and it will be seen, by the naked eye, that the first or whole vibration of the string will, in a very short time, be subdivided into a number of definite lengths, which will be seen in active motion; as well as certain points, which will be perfectly quiescent. If those points, which constitute the several terminations of the vibrating portions of the string, be now marked off, and correctly measured, they will be found to be simple multiples of each other. These lengths, or portions of the string, vibrate in certain definite times, with respect to each other; and, consequently, when tone is produced, perfect chords

are formed. Thus it is with the string of an Æolian-harp: when the string is struck by the wind, it vibrates in certain lengths or portions of the whole; all of which produce certain notes, and which are invariably found to be chords of each other. If the string is long enough to admit of it, its tension not too great, and the wind favourable, thirds, fifths, octaves, &c. are all given out from the same string.

In the foregoing experiment, and also in examining the division of the monochord, it will be seen that definite lengths of string, under the same circumstances, produce a definite number of vibrations; in virtue of which, combination is effected.

The same cause will also produce definite division; and, consequently, definite vibrations, from *circular* bodies. That this is the case, may be proved by the following very singular facts and experiments, which I accidentally discovered, a few nights since, whilst inquiring into the nature of a very different subject; and which prove the connexion between these subjects, when viewed in the light of analogous cause and effect.

Take a large goblet (the larger the better); and having filled it two-thirds with water, produce a tone from it, by rubbing with the hand (previously wetted), or a rosined bow, on the outside of the rim, in the same manner in which the musical-glasses are played; but with this difference, that you confine the friction, as much as possible, to *one* point, until the tone is produced. *Four* points only, of the circle of the glass, will become agitated, and these at *equal distances* from each other; and which points may be distinctly seen, by observing the rippling they make on the surface of the water. If the tone or note be now raised to a fifth from the first, (which may be easily done, after a little practice,) *six* points, in the sides of the glass, will become agitated; indicating that six portions of the circle are in motion. If, now, you raise the tone to the octave, *eight* points of agitation will be distinctly seen.

A large bell-glass, supported steadily on a foot, is more

easily made to produce these different tones, by the wet hand, than a common goblet; and the rippling on the surface of the water will be more defined and distinct.

To make the experiment more striking, suspend, by threads, from a ring placed over the glass, and equal to it in diameter, eight balls of cork, painted alternately white and black; placed *equi-distant* from each other, and resting *lightly* on the inside of the rim of the glass. When the glass is agitated, on a point where one of the white balls rests, it will be seen that all the black ones will become agitated, start forwards, and cross each other, in straight lines; whilst every other ball will remain at rest. This proves, that those portions of the glass on which the black balls rested are violently agitated; whilst those on which the white ones fall, are not at all affected. These points, it has been before observed, are definite divisions of the circle of the glass: and are alternate, with respect to each other. Suspend a number of small balls of cork all around the outside of the rim of the glass, in the same manner as those were suspended within it, in the last experiment; and the points of vibration will be seen, by the agitation of the balls at certain points only: thus, four may be seen, as in the last experiment; and, when the fifth note is produced, six, &c. &c.

Musical and chemical combinations, I feel no doubt on my mind, depend, in a great measure, on similar, if not on the same regulations. Modulation, also, is an imitation of "definite proportions;" for every different note in the scale of music, in respect to time, is a simple multiple, or divisor, of the other.

I have observed the same results to obtain in electrical and magnetical phænomena; and, in fact, I doubt if there is a single branch of science in which its operations may not be traced. At all events, its action is calculated to lead us into new and very important views, with respect to chemical science.

EFFECTS OF TEMPERATURE ON MUSICAL INSTRUMENTS.

"*Solids* are expanded by heat: and an instrument, called the *pyrometer*, has been formed on this principle, for the purpose of measuring the degree of expansion that thus takes place.

This quality of heat, in expanding solids, particularly the metals, is a great disadvantage to the arts, in many respects. The greatest is, perhaps, that of its preventing our time-keepers from preserving their regular rate of going, in different temperatures.

I will here relate a great disappointment and loss, as well of time as of attention and care, which once occurred to myself, in consequence of my ignorance of this quality of heat: and I mention the circumstance here, because it strikingly illustrates this property of heat, and eminently proves the necessity of connecting science with the arts.

Some years since, when a very young man, I undertook to build a large organ: and I succeeded even beyond my own expectations, which were yet sanguine enough; for it was admitted, on all hands, that the instrument which I produced was one of a remarkably fine tone. It was built on *theory*; for I had never seen the interior of one, till I finished mine; and knew nothing whatever, practically, of the construction of them. Flushed with this success, I did not see any reason, in *theory*, to prevent my connecting a piano-forte with my organ: on the contrary, I conceived that, by an union, the bad effect of the sudden stop of the organ would be remedied, in a great measure, by the cadence of the piano-forte; and the mixed tones of the two would produce an effect pleasing and harmonious to the ear. I ultimately succeeded in practice; and combined the two by the same set of keys; and also affixed pedals, so as to enable the performer to play the instruments, either separately, or together, as might please his fancy. The effect, certainly, was very delightful; and the expression far exceeded my most sanguine expectations. The instru-

ment being now complete, and in fine tone, I invited my friends to witness the effect of it; and, after waiting in anxious expectation, I was, at last, requested to play. I sat down, and, commencing with a fine slow movement, began presently to change my modulation and time, into what musicians call an "allegro." Now, then, was the moment to introduce the lively notes of the piano: accordingly, I removed my foot from the silent pedal, expecting to enrapture my audience, and to receive "showers of applause:"—but, judge of and pity my feelings, when I tell you, that, instead of a "concord of sweet sounds," my instrument poured forth the most frightful discords that ever fought together, for the especial discomfiture of musical ears! You may easily conceive my chagrin and disappointment. The mischief (as you will perhaps have anticipated) was occasioned by this property of heat, which we are now considering. The number of persons in the room, added to a better fire, perhaps, than was usual, raised the *temperature;* and, consequently, the metallic strings of the piano were *expanded* by it: their tension became diminished; and, of course, the notes were all flattened; whilst those of the organ-pipes were rather affected in the opposite way; so that they produced, together, a complete separation and discord. The next morning, when the temperature of the room was reduced, the instruments were again in perfect tune.

ON THE CAUSE OF THE PRODUCTION OF MUSICAL TONES FROM BURNING HYDROGEN GAS.

Make to issue, from a long jet, a stream of hydrogen gas: inflame it; and invert over it, a glass tube, of about half an inch in diameter:—a *peculiar musical tone* will be produced. I find that the same effect is produced by burning hydrogen, or carburetted-hydrogen (coal-gas), in the neck of a wine-bottle. At first, no tone whatever is heard; but, as soon as the oxygen it contains is combined, and the flame calls upon the atmosphere without for support,

the musical tone commences. This tone appears, to me, not to be occasioned by a series of detonations, as is generally stated, but by a mechanical action of the air upon the lip or mouth of the bottle: so, also, in the case of the tubes; for the tone which is produced from both is of the same quality as that produced by blowing into them. If the tone was occasioned by a series of detonations, the quality of it would be governed by the *rapidity* of those detonations, and not by the *depth* of the bottle. The latter invariably regulates the pitch of the tone, when thus produced. The situation also of the flame confirms this idea; for it must be so placed, that the angle formed by the current with the mouth of the tube or bottle does not differ from that necessary to produce tone by common blowing. This also accounts for the length of tube required to produce tone; for, in order that the current should not be slow, a length of tube, equal to two feet, will be necessary. As the angle is made to change, or as the current varies, so, also, the tone varies, from the fundamental, to the fifth, third, &c.: again, a short tube will not produce a tone at all, unless a very strong current is made to ascend from below, upwards, either by rarefaction or by combination. In a large stone bottle, or jar, the tone is similar to the lowest tone of the violoncello; and in all the experiments I have made, the true tone, from hydrogen gas, is always governed by the size and depth of the tube or bottle, agreeably to the laws observed in other bodies.

LXXXII. — *On the Cultivation of Osiers. By Mr.* JOHN SHIRREFF.*

Captain-Head; near Haddington, North Britain, Nov. 19, 1802.

SIR,

I have taken the liberty to address the following Essay to the Society for the Encouragement of Arts. It contains

* From Vol. XXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted its Gold Medal, or Thirty Guineas, at his option, to Mr. Shirreff, for this valuable communication. He preferred the former.

every useful information, as far as at present I can recollect, which I have, during several years' attention to the subject it treats of, been enabled to acquire. Perhaps I have been too prolix and particular; but let me hope that an anxiety to be clearly understood—joined to an ardent wish that any person intending to plant osiers may be able, from the perusal of this Essay, to adopt reasonable means for promoting their successful cultivation and vigorous growth—may plead my excuse.

I have the honour to be, Sir,
Your most obedient servant,

To C. TAYLOR, *Esq. Sec.* JOHN SHIRREFF.

To a mind deeply impressed with the high national importance of encouraging the cultivation of every species of useful production of the soil of this island, it affords most sensible delight to notice the encouragement and flattering rewards extended to agricultural pursuits, by the Society for the Encouragement of Arts.

It was not, however, with a view to obtain any premium, that the *Salictum* described in the sequel was established, but as the most profitable mode of employing the ground it occupies. Indeed, it was only in the course of last summer that the writer of this little Essay came to know that the Society had offered any premium for the cultivation of osiers. When he comes forward in competition, he must rest his humble pretensions to reward on the simplicity, and perhaps correctness, of his mode of culture, together with the value of the produce in consequence thereof; and not on the extent of ground planted with osiers.

The ground planted in the winter of 1801-2, contains, as by Certificate (under cover with the Letter which accompanies this), seven acres, two roods, and one pole. It is situated in a bottom, sheltered from the west and north winds, by hedges and hedge-row trees; but is exposed to the south and east, the fences being low on these sides.

The soil may, generally, be denominated a clayey loam, of a coarse quality. It had, probably, till about thirty-five years ago, been under natural meadow; and a considerable part of it was subject to be flooded in winter. An open drain or ditch, six feet wide and three and a half deep, cured it of this inconvenience. It had, afterwards, been in the rotation of crops, common to the practice of good agriculture in the district; and frequently laid down to pasture, in excellent preparation, for several years, at different times since that period. The pasturage, however, was but coarse; and the crops of grain, excepting oats, were seldom valuable.

In the spring of 1801, it was carefully under-drained; having been ploughed the preceding autumn, to mellow the soil, in preparation for turnip and *uta-baga;* for which the piece was afterwards fitted, by repeated ploughings, &c., and manured with about sixteen double-horse cart-loads of good stable-yard manure to the statute acre. The turnips and *ruta-baga,* being drawn in October and November, about the 1st of December 1801 the planting commenced; the land having previously been ploughed up, with deep furrows, into ridges, or beds, eighteen feet wide. The rods, used for plants, grew immediately contiguous, on a part of the same field, on which a plantation had, five years before, been established. These rods were of great length and considerable thickness, and would have made good hoops. They were cut from the stocks, chopped into pieces of a foot long, on a *smooth* block of wood, by a light and very sharp hatchet; and all of them were put into the ground, at the price of two shillings per thousand cuts. The hands of the planters were guarded by a piece of neat's leather, with a hole in it for the thumb to pass through, in order to keep it in its place, and to save the palm from injury; and it was also fixed on the hand by a strap of the same material passing round it. A common garden-line, about sixty feet long, divided with slips of leather, at the distance of eighteen inches from each other, was used in

planting. Two planters began at the middle of the line, and proceeded, sticking in the cuts, towards the extremities; where they both generally arrived at the same instant, and shifted the line to new ground; a measure, of eighteen inches long, being used at each end, to determine the distance between the rows; so that the plants stand eighteen inches apart in every direction. The cuts were struck off aslant; and were pushed into the ground with the slanting face made by the hatchet, turned downwards, lest rain should run into the pith, and rot the stock. The plants, or cuts, were put in sloping, at an angle of about 75 degrees; and pushed in, almost down to the surface of the soil. An inconvenience, however, arose from pushing the cuts so far home; and the advantage of easily preserving a handsome stock or head for several successive years, was in a great measure counterbalanced, by the tender shoots, which sprang at and under the surface, being exposed to the attack of grubs, in the same manner that grain is, in May, and as was the case in some spots of the plantation under description. The lower the shoots spring from the stock, the more readily do *slugs* find access to them. From all this experience, the writer conceives it to be safer to make the cuts from fifteen to seventeen inches long; and to allow four or five of these inches to remain above ground, to be cut over, at the surface of the soil, when the heads of the stocks, in a series of years, shall have become too bushy. By this operation, the vigour of the plants is renewed in the most effectual manner. An instance of its efficacy came to the writer's knowledge about two years ago.

In the month of May last, the whole ground, planted during the preceding winter, was hoed over; the surface being completely moved, to the depth of an inch and a half, for five pounds ten shillings by the piece. The ground being then remarkably dry, strong heavy hoes, with long heads and narrow faces, were used. It was hoed again in June, for two pounds ten shillings, with

Dutch or *shoving* hoes. This operation made the surface as fine and clean as any garden-ground. The showers in July, and the hot weather in August, bringing up a new flush of annuals, made it necessary to hand-weed the whole, about the last week in August, and the first in September. The hand-weeding was performed, chiefly, by women and children, at from 4*d.* to 7*d.* per day; and cost one pound thirteen shillings. In some places, young plants of the *ranunculus repens* made their appearance; no doubt from latent seeds, this being a perennial plant, and growing close to the surface of the soil: the Dutch hoes were applied a second time; with which, the plants of it were cut off below the bulbs: this operation cost above seven shillings more.

The writer had planted about five statute acres, at two different periods, prior to 1801, with osiers. These have, one year with another, netted fully eighteen pounds ten shillings an acre. About three-quarters of an acre were reserved, standing three years, for cuts to the seven acres two roods and one pole, established last winter: the remaining four and a quarter acres netted one hundred guineas last season, paid at Candlemas, for one year's growth; deducting about two pounds seven shillings for hoeing and trimming in the preceding spring. The whole osier-ground in the writer's possession, which extends to twelve and a half acres, statute measure, including the ground planted last winter, is to be cut in November and December 1802, being all a single year's growth. The price is two hundred and twenty pounds, to be paid at Candlemas next; and, if not all cut before next Christmas, by special agreement, the price is to be two hundred and fifty pounds.

The sorts of osiers in the writer's plantations, are; The *viminalis*, or common. A variety, with darker-coloured bark, and slenderer shoots, more esteemed. Another sort, which the writer had originally from Surrey; the leaves of which are large, long, sharp-pointed, serrated, of a bright

green, and smooth on both sides; the bark reddish, where exposed to the sun and air; the shoots thick at their lower extremities, tapering much towards their points. A fourth sort is a valuable osier, with bark of a dusky-ash colour, and as it were fluted in the longitudinal direction of the shoots towards their smaller extremities: the leaves are serrated, pale green, and smooth on both sides. A fifth kind, much resembling that last described; the leaves of which are also pale green, smooth on both sides, and serrated, but narrower, smaller, and sharper pointed: its bark is not so dusky, it grows taller, and produces more shoots than that last described; but though they are good twigs, yet they are rather inferior to those produced by the former of the two. These are the principal varieties, composing the plantation submitted in competition. There is also a small patch of the Golden-willow; and another of what is called the Packthread, in this district:- and there are about thirty square yards of each sort.

The whole of these osier-grounds are so situated, that water may be thrown over them at pleasure, for a sum of money under five pounds. Not that there is as much water as would serve to refresh the whole at once, in dry weather in summer, but only each bed in rotation: a continual supply being afforded by strong springs, carried off, by covered drains, from fields more elevated. This improvement is meant to be put in practice next summer; for, *although wet ground is by no means necessary to produce good osiers; water, at command, is,* by the writer of this Essay, *considered of no small importance to the whole vegetable world.* It is from the luxuriant growth of part of his principal plantation, to which water is given at will, that the writer concludes in favour of watering in dry hot weather. The part alluded to is a bank of good earth, thrown out of a deep ditch, or open drain, that skirts the whole of the north and west sides of the ground. This bank is about four hundred yards long; and, on an average, may be three and a half broad. It had, for many

years, been covered with thistles, docks, hemlock, &c.; and though these had been frequently mowed over, and more than once were grubbed up with the spade, they soon again became a nuisance. In the winter of 1798, it was trenched to the depth of two spades and a shoveling, and planted with osiers. The water had been sent in another direction in severe weather; and, in very dry weather, was again turned into the drain immediately behind the bank; and part of it into a small cut on the south side, in front. On this bank, formerly a nest of weeds, the writer has reason to think that more value has grown, every year since it was planted with osiers, than on any piece of land, of the same extent, within some miles of it.

The grand errors, into which most persons fall who attempt to establish plantations of osiers, seem to be the following:—employing improper soil, peat-earth perhaps, or poor bog; imperfect, or, perhaps, no preparation of the soil, though it might be proper in other respects; bad or useless sorts planted; too few cuts put into the ground; want of culture, particularly during the first spring and summer after planting; allowing the shoots to be cut over after Christmas, and before the middle of March, which may be the cause of the stocks being much weakened by hard frosts succeeding heavy rains, immediately after the twigs have been cut, and before the wounds from the knife are healed up. If it is expected to rear the finest and most valuable twigs, the land must be cured of chilling, weeping springs; and if the soil is not of considerable richness, it must be made so, with manure. Moderate moisture is favourable to the production of fine twigs; but *water continually stagnant* may be considered as ruinous. The writer has seen good osiers grow, where water stood, in the bottom of an old ditch, during the greater part of the winter months; but thinks that water continually stagnant is very destructive in summer, by preventing the wood from ripening: and he apprehends, that, where good osiers grow in water, the roots must reach sound dry soil imme-

diately contiguous; which was the case in the instance mentioned above: for the soil was dry, and moderately rich also, on each side of the ditch. It may also be considered necessary to trim and dress the stocks from decayed wood; and to leave only as many buds on each as it is thought the plant will bring to good perfection, in length and strength of shoot; cutting down the superabundant stumps to the old wood, extirpating the weakest shoots or stumps, and seldom leaving more than two buds or eyes on those made choice of, to stand to produce the next summer's growth.

This operation should be performed either in November or the beginning of December, or in the end of March or beginning of April; going regularly over the plantation, examining every stock with attention, and trimming it to the best advantage, with a strong sharp pruning-knife. All this can be done for a trifling expense, if the stocks are trained from the beginning, and regularly and carefully trimmed every time the plantation is cut over. Instead of an infinite number of small weak shoots, the longest, probably, little above four feet,—as may be observed in those plantations where no attention is paid to training and trimming the stocks, or pains taken to keep down weeds and grass by careful and regular hoeing,—the writer has the satisfaction to say, that, by pursuing a different and opposite management, the shoots on his plantations of osiers, established prior to 1801, are from four to nine feet long, and of the best quality. Where any plants have failed, their place should be early supplied, that is, next season, as soon as the plantation is cut over. Pieces, two feet and a half long, may be used for cuts; allowing eighteen inches to remain above ground, for air and head-room, during the following summer. Indeed, a greater length of the rod put in the earth would afford these advantages still more decidedly; but it is conceived that the superior power that would thereby be given to the winds, to agitate the roots, would counterbalance the benefit of the additional air and head-room which by that means might be attained.

The writer is of opinion, that either the method he adopted, of taking a crop of turnips, and drawing or storing it; or, what he practised on the part of the same ground planted in the winter of 1796-7, viz. summer-fallowing the ground, and manuring in the preceding summer; or else, trenching the ground, where the depth of soil will allow; will prepare ground to bear osiers with a reasonable prospect of success.

He also conceives, that the value of the produce of his plantations, and the thriving state thereof, confirmed by the Certificates and most respectable reference to satisfy the Society of the price he has sold it for, which accompany this Essay, tend strongly to prove, from *facts*, that his modes of cultivating osiers are not the worst that ever were adopted. If they meet with the approbation of the Society of Arts, it will afford no small satisfaction to

SALICTICUS.

The Certificates alluded to in the above Essay, are, from ROBERT LORIMER, D. D. Minister of Captain-Head; DAVID SHIRRING, Farmer, and ANDREW PRINGLE, both of the same place; WILLIAM DICKENSON, Land-surveyor; ROBERT WILSON, and GEORGE BROWN, of Balincrief; and JOHN CROUCH, Basket-maker, of Edinburgh.

On the Secretary writing to Mr. Shirreff, in the usual mode, to know whether he would accept the honorary or pecuniary reward of the Society, he returned the following answer:

SIR, *Captain-Head, near Haddington, April 25th,* 1803.

I lose no time in acknowledging the receipt of your highly-esteemed favour of the 19th instant; which came to my hand only with this morning's mail.

Seldom has any circumstance in my life afforded me more genuine satisfaction, than this honour conferred upon me by the Society of Arts. Heaven knows, I am not rich: yet I should think but meanly of the man who could put

a much greater sum of money than thirty guineas in competition with any of the honorary rewards of the patriotic Society for the Encouragement of Arts, Manufactures, and Commerce. I give a decided preference to the honorary medal of the Society: and hard must be my fate on that day on which I part with it!

We begin to drill turnips, in this district of the island, about the last day of May, and the first of June. If I can possibly arrange matters, to enable me to be so long absent from my business, it will give me high satisfaction to attend personally at the Society's house on the 31st of May next, to receive the medal from the hand of his Grace of Norfolk.—I have the honour to be, Sir,

Your most obedient servant,

CHARLES TAYLOR, *Esq. Sec.* JOHN SHIRREFF.

LXXXIII.—*On a convenient Stand, or Support, for Chemical Test-Glasses, Small Matrasses, Capsules, &c. Invented by the* EDITOR.

WITH FIGURES.

IT must have been obvious to our Readers, that a principal object with us has been, to enable persons to help themselves, on an emergency, by constructing any apparatus they might require, in the easiest, cheapest, and simplest manner: and the contrivance about to be described, exactly answers this end.

Having occasion, lately, to support a number of test-glasses, in a vertical position, in an experiment the Editor was making, he hit upon the following facile method of forming an extempore stand for that purpose.

In Plate XIV, fig. 3, is shewn part of an iron cylindrical wire or stem, of its real thickness: it is about eight inches long; and its lower end is firmly affixed in a brass pedestal filled with lead; being, in fact, part of a stand for supporting a magnifier or megalascope. To accommodate this to

the purpose required, he wound a piece of *tinned-iron wire*, of the thickness shewn in the figure, around it, so as to make six or seven turns; and then bent the extremities of the wire into the shapes represented; (which are, however, better seen in figs. 4 and 5.) He thus obtained a kind of tube or socket, capable of sliding up and down upon the stem, and of being turned into any position around it: and, in case of the socket not sliding with a sufficient grasp upon the stem, to render it capable of supporting the test-glasses and their contents, he had only to place three of the coils upon the upper end of the stem, and, using the wire-arms as levers, to bend a little the other three coils constituting the socket; thus creating a springiness or elasticity in it, which he could increase or decrease at pleasure, so as to suit the required degree of tightness. He also further availed himself of the elasticity of the wire, in causing it to clasp the tubes of the test-glasses firmly, and thereby to hold them much more steadily than could be accomplished in the usual stand: this he effected by leaving the loops open; and, having fitted them to the diameter of the tubes, and turned back the ends of the wires, as shewn in the different figures, he could readily introduce or remove the tubes at pleasure, and also fix them firmly in the loops, by first closing them a little. In this way, a single loop alone was sufficient to hold a test-glass sufficiently firm, when it had a rim to it. In the case, however, of supporting those glasses when without rims, he coiled up one arm of another wire-socket into the flat spiral shape shewn in the figures; which answered the purpose completely.

The stem was capable of receiving six or more of these wire-spring sockets, with their double arms and loops, upon it; and it thus could well support twelve, at least, of the test-glasses around it. Small matrasses, and capsules, were also very conveniently held, in loops adapted to receive them; and, owing to the pliancy of the wire, it could be readily bent, even under the fingers, without the aid of pliers, into any shape required; excepting the turning back

of the ends of the wires, which, of course, needed their help.

Although this stand was originally intended to answer merely a temporary purpose; yet the Editor finds it so exceedingly convenient, that he purposes to employ it, on every occasion, where it is requisite.

LXXXIV—*On a Set of Cast-iron Rings for enlarging or contracting the Mouths of Wind-Furnaces, &c. Invented by the* EDITOR.—*And on improved Methods of making, and securing from warping, the Patterns, for casting them, and other Articles from.*

WITH FIGURES.

A READY method of contracting or enlarging the mouths or apertures in the tops of the wind-furnaces used by founders, or of the furnaces used by chemists, type-founders, &c.; so as to cause them to be capable of being opened or closed readily, or of receiving into them vessels of various sizes, such as melting-pots, sand-pots, distilling vessels, &c.; at the same time closing the apertures perfectly, and thereby preventing the entrance of air from above; will, no doubt, be duly appreciated by all persons in the habit of employing such furnaces.

The Editor believes that he has completely effected this important object, by the invention of a set of different-sized rings, made of cast-iron, shewn in section, in Plate XVI, fig. 1, at *a*, *a*, *a*, &c.; and one singly, by plan and section, in figs. 2 and 3. It will be seen that the exterior or largest of these rings lodges in a groove, *b*, *b*, formed in the covering-plate *c*, *c*, of the furnace; the upper part, only, of which is shewn in section; and carries in itself another groove, into which the second smaller ring is received, and supported in a similar manner; and so are all the others: the orifice in the central one being closed by a cap, *d*, which fits into the groove around it. Sand being then sprinkled over all, so as to fill up the remaining spaces in the grooves,

it is evident that a perfect closure of the mouth or aperture of the furnace will be effected. In order to render the removal of these rings more facile, two wrought-iron loops may be riveted into each, as shewn in fig. 3, and one of them in fig. 2. And, in order to effect a perfect closure around a vessel, such as a sand-pot, a type-founder's melting-pot, &c., the vessel itself ought to have a re-curved rim, similar to that shewn at *e*, *e*, in fig. 4, made to lodge in the groove of any one of the rings, which is fitted, by its size, to receive it.

These rings may be either made round, as shewn in the figures; or square. In the first case, the original patterns, for casting from, may be readily made, by moulding plaster of Paris, in annular forms, upon the surface of a flat plate of wood or metal, capable of being fixed upon the mandril of a lathe; and of a sufficient substance, to admit of being turned into shape, on one side; and then to be reversed, again fixed upon the flat surface by cement, and be finished by turning the opposite side into shape. These patterns, owing to the homogeneous nature of the plaster of Paris, may be thus readily formed; and, after being impregnated with boiled linseed-oil, will make excellent patterns, not liable to warp in the moist sand-moulds, as wooden ones would do. For square rings, the patterns may be very readily made of wood, shaped by moulding-planes, and joined firmly together at the corners: after which, they may be defended from the moisture of the sand, in moulding them to cast from, either by several coats of oil-paint, in the usual manner of pattern-making; or, which is still better, in the manner of the astronomical and mathematical instrument-makers, who, after forming their beautiful models, in hard mahogany, of the exact shapes they wish the metal casts to possess, — *which is certainly much more easily performed in wood than in metal*,—effectually preserve them from the effects of damp, by coating them with several layers of seed-lac spirit-varnish. This latter practice well deserves to be adopted, in all cases where it is desirable to

preserve wood-patterns for casting from, in their perfect shapes.

The Editor knows, that, at a celebrated iron-foundry and engine-manufactory in the northern part of England, the Proprietors expended vast sums in having patterns of toothed wheels made in wood, and painted in the usual manner: they had also one pattern, a bevel-toothed wheel, made of hard mahogany, and secured by spirit-varnish, in the manner recommended above. In the course of a very short time, all the common wood patterns became more or less warped out of shape; whilst the varnished mahogany one remained as perfect as it was when first made. This fact is fully sufficient to prove the necessity of adopting a better system of wood-pattern making.

When once a set or sets of patterns, for the furnace-rings, shall have been formed, and cast-iron ones made from them, the multiplying of them will become a mere matter of course; and, no doubt, the manufacturer who should first put himself to the expense of forming them would soon be amply remunerated, by the demand for them which articles of such manifest utility must inevitably soon create.

LXXXV.—*On a safe and economical Method of burning Wood-Shavings in Workshops, and converting them to useful purposes. By Mr.* Joseph Davis.*

WITH A FIGURE.

Sir, *Catherine Street, Jan.* 12, 1813.

The great number of manufactories destroyed by fire, in consequence of the large quantities of loose shavings, of carpenters, joiners, cabinet and musical-instrument makers, &c. in the shops; the men not liking the trouble of burning them in the common way; and it not being at all

* From Vol. XXXI. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.—The Society voted its Silver Medal to Mr. Davis, for this useful contrivance.

times convenient for the porters to remove them; they frequently accumulate to a dangerous extent;—which was the cause of the fires at Messrs. Clementi and Co.'s, and at Messrs. Wilkinson and Co.'s, in Oxford-street.

To prevent such risks, I have tried several experiments; and have accomplished a method, which far surpasses my most sanguine expectation.

The machine, for the above purpose, is made of plate-iron, one foot diameter, sixteen inches high, in a cylindrical form; with a flat top, having a round hole in it the size of the cover for the stove on which it is fixed, that the cover may answer for both purposes. It has an iron handle, with ears like a pail, to take it off the stove with, when not wanted.

By this invention, the shavings become a valuable fuel; the work can be done much superior, than by coals; and the risk of fire is, in a great measure, done away.

I shall be happy to shew any gentleman the improvement, in use at my manufactory, in Catherine Street, Strand.

I am, Sir, your obedient servant,

JOSEPH DAVIS.

To C. TAYLOR, M.D. *Sec.*

SIR, *Catherine Street, Strand, Feb.* 4, 1813.

Since I had the honour of waiting on the Committee of Mechanics, on Thursday last, I have endeavoured to ascertain the true merits of the invention, by further experiments in the presence of a number of friends, and also of Mr. Gill, one of the Chairmen of the Committee of Mechanics; when the cylinder, 13 inches diameter, and 15 inches in height, being about seven-eighths filled with shavings, burnt for more than half an hour, and produced a degree of heat much greater than from coals.

Before I discovered this means of consuming shavings, the men, in the winter season, could not have the veneers, cauls, &c. ready in the workshop, in a proper state to be put together, till the middle of the day; which may now

be done in one hour: and, in the evening, it was necessary to make a very large coal fire at the time the men were leaving work; that being the time they generally completed their largest glueings for the day; in order that they might have the advantage of the night, to set the work, to be ready the next morning to clean off. In using a coal fire, there is not only a great risk, from the shavings not being consumed, but lying about the shop; but the fire, when put out with water in that state, often occasions the cast-iron parts of the stove to crack. The cylinder removes the danger of the one, and the inconvenience of the other; as the men can at pleasure regulate the heat or duration of it, by putting in the shavings: as, for example, if the cylinder be one-fourth filled, it will give a strong fire for five minutes; if one-half, for fifteen minutes; if filled close, for three-quarters of an hour; and, when done with, the sweepings of the shop will remain burning, if not put out with water, for one hour longer. I have one now making on the plan of that shewn in the drawing: it will cost ten shillings, and, with a little alteration, may be applied to any stove, where great heat is wanted; and if cinders or ashes be mixed with the shavings, it will burn (though not so brisk) for several hours; but requires a little more attention, to prevent it from smoking, by keeping the pipe clear, and putting in small quantities.

I have stated the above particulars, conceiving they will be of great use to many manufacturers and others.

I remain most respectfully, Sir,

Your obedient humble servant,

JOSEPH DAVIS.

To C. TAYLOR, M.D. *Sec.*

CERTIFICATES.

We hereby certify, that we have seen Mr. Davis's invention in use, and consider it a great security against accidental fires in manufactories, by its consuming the shavings as they are made; that it is a saving of fuel, and a

superior mode of preparing the work, before it is put together.

JOSEPH HAMMERSLEY, Cabinet-maker, Great Prescot-street.
GEORGE ASTOR and Company.
GEORGE PRYER, Cabinet-maker, No. 30, Brydges-street.
WILLIAM STRATTON, Stove-grate Manufacturer, Gutter-lane.
W. D. HARLEY, Musical Instrument-Maker.
J. W. MOORE, Ironmonger, Brydges-street.
JOHN ABDEY, Organ-Builder.

Jan. 12, 1813.

Reference to the Engraving of Mr. Davis's Stove, for burning Wood-Shavings, in Carpenters', Joiners', Cabinet and Musical-Instrument Makers' Workshops.—Plate XVI. fig. 5.

The object of this contrivance is, to employ shavings as fuel, instead of coal; by such a construction of the stove, that they will not blaze away too fast, as they do in an open fire; making an intense heat, but only of a momentary duration. This is effected by putting the shavings into a sheet-iron cylinder, closed at top; which is fitted into the top of a stove, very similar to those always used in such situations for burning coals; and the flame produced by the shavings, passed through flues, conducted in the usual manner; the air, which supports the combustion, being supplied through the bars of the grate.—Fig. 5 is a perspective view of this stove; in which A A represent part of the interior wall of the workshop, where the stove is placed.

B, the stove, which is made 12 inches wide, and 1 foot 3 inches high; it is of cast-iron, and lined with fire-tiles, having a door or fire-grate, with an ash-pit beneath, in the usual manner; C, the sheet-iron pipe, 6 inches wide and 4 inches deep, which conveys the smoke and flame from the stove, into the brick flue, at D; and this leads into the

chimney, at E. F, is an iron door, opening into the chimney, for the sweeping-machine, or boy, to pass through, to sweep the chimney. G, the sheet-iron cylinder, in which the shavings are put to be consumed; which is about 9 inches in diameter, and 16 inches high: it is placed over a circular aperture, in the top of the stove, B; and has a neck, shewn by the dotted lines, to fit in the hole of the top of the stove, to prevent the sparks of the shavings from flying out into the workshop. The cylinder is covered at top, with a lid, H; having also a neck, which is removed at pleasure, by its handle, I, to put in a supply of shavings: this fits very close; and, as no air can pass by it, a sufficient draught to burn the shavings, but slowly, is afforded, by the air passing through the bars of the grate, which is impeded by the ashes which may be therein; but this flame may be increased to a rapid combustion, when necessary, by opening the door of the stove: the flame passes along the flues, C and D, and gives out an equable heat to the room. Iron-bearers are fixed across the flue, C; which may be used to support any work which requires drying, or for any other purpose of this kind.

The supply of this stove with fuel, from shavings, is attended with so little trouble, and is such an advantage to the workmen, that they will always prefer burning the shavings to coals; so much so, that where ten men are at work, there is a difficulty to collect shavings sufficient, even to light the fire the next morning.

By this means, the danger of fire, which has been fatal to so many manufactories, is greatly removed; the loose shavings being consumed as soon as they are made, and that in lieu of more expensive fuel: and so slow are the shavings consumed, that the iron cylinder will hold enough, when crammed full, to supply the fire for upwards of half an hour. To guard the workshops still more effectually from danger, the stove and its iron flue is supported upon a mass of brick-work, which prevents any sparks, &c. from falling upon the floor; and the sides of the brick-work afford very conve-

nient shelves, on which to lay any wood-work that requires heating, drying, &c.: and when a greater heat is required to extend to a considerable length horizontally (as, for instance, four or five feet), by merely putting a few shavings into the cylinder frequently, in place of filling it, they become converted into flame, which is carried the whole length of the iron flue, heating it uniformly throughout. No soot lodges in the flue, but merely light ashes; which can be easily cleared out, from time to time, as may be necessary.

LXXXVI.—*On various Preparations of Carmine.**

Carmine, according to the opinions of MM. Pelletier and Caventou, is a triple compound, formed by the union of the colouring substance, and an animal matter contained in the cochineal, with an acid, which is added to effect precipitation. The preparation of this article is still somewhat involved in mystery; for the consumption of it being limited, very few persons are employed in its manufacture; and the original material, the cochineal, being always at a very high price, experiments of this kind become expensive. It is nevertheless to be presumed, that, assisted by the information afforded by MM. Pelletier and Caventou, it will now be easy, for those who wish to pay attention to this species of manufacture, to succeed in discovering the secret. We must observe, however, that success appears principally to depend on a certain dexterity, which habit alone can confer. It is not sufficient to have a good receipt, in order to succeed: it is likewise requisite that the eye be sufficiently accustomed to distinguish when the colour of the bath has attained the highest degree of beauty. This operation requires, likewise, that the manufacturer be well versed in the method of stopping the action of the heat at the proper moment. After these preliminary observations, I shall proceed to transcribe some of the most-approved recipes, and such as I have had executed, with success, under my own eye.

* From the *Dictionnaire Technologique*.

Various sorts of carmine are sold at the colour-shops, which are distinguished by the order of their numbers, and are of a relative value. The difference arises from two causes; either from the proportion of alumine added to it, in the precipitation; or from a certain quantity of vermilion mixed with it. In the first case, the colour is weakened: in the second, it does not retain the same brilliancy. It is always easy to perceive the proportion of the mixture, by the property which pure carmine possesses, of dissolving in ammonia. All the foreign matters remain untouched; and their proportions may be estimated, by drying the residuum.

COMMON CARMINE.

1 pound of powdered cochineal.
3½ drachms of sub-carbonate of potash.
8 drachms of alum in powder.
3½ drachms of isinglass.

The cochineal is first boiled with the pot-ash, in a copper boiler containing five pails of water: the effervescence is stopped with cold water.

After having boiled for some minutes, the boiler is removed from the fire, and placed on a table, so inclined, that the liquor may be easily poured off.

The powdered alum is then thrown in, and the decoction stirred; when it immediately changes its colour, and turns to a more brilliant tint. In about a quarter of an hour, the cochineal is deposited at the bottom; and the liquid is as clear as if it had been filtered. It contains the colouring matter, and probably a little alum in suspension.

The liquor is then decanted into another boiler of the same size, and set on the fire; adding to it, isinglass, dissolved in water, and passed through a sieve.

At the moment of ebullition, the carmine is seen rising to the surface of the bath; and a coagulum is formed, similar to that which takes place in the clarifications made with the whites of eggs.

The boiler must be withdrawn from the fire, and the bath be stirred up with a spatula.

In fifteen or twenty minutes, the carmine is deposited; the liquor is then decanted; and the precipitate laid to drain, upon a very fine sieve.

MANNER OF PREPARING THE ISINGLASS.

After having cut it into small shreds, it must be allowed to remain in water for one night; during which time it will swell prodigiously, and absorb a large portion of water: it is then put into a proper vessel, and, by means of heat, reduced to a transparent jelly, which instantly melts on being put into hot water.

Similar recipes may be found in many works; but, instead of isinglass, the whites of eggs, and sometimes even the whites and yolks together, are prescribed.

If the operation has been properly performed, the carmine, when dry, will easily break between the fingers.

The more the pot-ash is carbonated, the more friable is the carmine.

What remains, after the precipitation of the carmine, is still greatly coloured; and may be advantageously employed in the preparation of red lakes.

FINE CARMINE, KNOWN AT PARIS BY THE NAME OF ENGLISH CARMINE.

Four pails-full of river-water are made to boil in a large copper vessel: two pounds of hot water are drawn off, and passed through a very fine sieve, into an earthen vessel containing five eggs which have been previously beaten up together with their shells: this forms a kind of emulsion, which is to be preserved apart.

A filtered ley, made of ten drachms of soda of Alicant, dissolved in four pounds of boiling water, is then poured into the vessel; and, at the same time, a pound and three-quarters of cochineal, grossly powdered, is added: this is to be kept constantly stirred with a brush having a long handle, and allowed to boil for half an hour: the vessel is then removed from the fire, and fifteen drachms of pulverized Roman-alum are added; and it is once more stirred up with the brush; then left at rest for ten or twelve minutes, till it is seen that the violet colour has changed

to a very deep scarlet red. The liquid is then decanted into a boiler, and the aforesaid emulsion added to it; after which it must be boiled up again. The carmine is then poured upon a fine linen cloth, extended upon a frame or stretcher. The red liquid, which passes through, is received into a wooden vessel, and is employed in the preparation of lakes. This operation, in all other respects terminates like the former. The carmine is reduced to powder, passed through a fine sieve, and preserved in tin boxes.

SUPERFINE CARMINE; TERMED "MADAME CENETTE'S, OF AMSTERDAM."

Six pails-full of river-water are put into a boiler, and set on the fire. At the instant when boiling commences, two pounds of cochineal, finely powdered, are added. After two hours' boiling, three ounces of pure nitre are put to it; and, presently afterwards, four ounces of salt of sorrel. After allowing it to boil ten minutes longer, the boiler is removed from the fire, and left at rest for at least four hours. The water is drawn from the carmine with a siphon, to be distributed into several earthen vessels, which remain for three weeks upon a table or bench. In a short time, a thin skin of mouldiness forms upon the top; which is removed, with a small sponge tied to the end of a stick: the water is then drawn off by a siphon, which may be plunged to the bottom of the vessels; for the carmine is so firmly attached to the vessels, that it seems to form a part of them. This carmine, when dried in the shade, is almost too brilliant for the eye to endure.

(To be continued.)

LXXXVII.—*On extracting the Colouring Matter from the Carthamus.**

CARTHAMUS, or Bastard Saffron, *(safranum, carthamus tinctorius,)* a plant of the *syngenesia polyg. æqualis* of Linn., the *flosculosi* of Tournefort, and the *cinarocephalæ* of Jussieu, is an annual; grows spontaneously in Egypt, of which

* From the *Dictionnaire Technologique.*

it is a native; and is cultivated in India, and some parts of Europe, on account of its valuable properties for dyeing. It has a straight, firm, smooth, and whitish stem, two or three feet high; which is divided towards the top into many branches, furnished with leaves that are simple, entire, oval, pointed, and bordered with prickly teeth; each branch being terminated by a somewhat large flower, in which the scales of the calix are spinous, the florets hermaphrodite, and the corols, which have five segments, of a beautiful red-saffron colour.

The corol of the *safranum* is usually gathered as soon as the flower begins to open, because it loses its lustre when it is more fully blown. It must be dried in the shade, and preserved from any damp or moisture. It is the more valuable, in proportion to the brightness of its tint. When it has a dusky hue, it is a certain proof that it has either been gathered in a rainy season, or badly dried, and that its colouring matter is greatly deteriorated.

The corol, which is also called the flower of the carthamus, and commonly *safflower*, is very much used in dyeing. It contains two colouring matters; one of a reddish yellow, which is rejected as useless, because it produces only inferior shades; the other, which is of a beautiful red, serves to produce every shade, from the most delicate rose to the deepest cherry-red. The first easily dissolves in cold water; whilst the second, which is of a resinous quality, does not possess the same property. In order to separate the one from the other, it is sufficient to wash the carthamus under a small jet or stream of water, which removes the yellow colouring matter. When the water becomes colourless, the washing may cease, and the carthamus be macerated in a weak solution of soda: the bath soon becomes coloured of a darkish yellow red. When it is thought that the maceration has been sufficiently prolonged, it is passed through a sieve or filter; then carded cotton is plunged into it, and a vegetable acid is added, until the alkali is completely saturated. Lemon-juice is generally

preferred, because it renders the colour more vivid. The carbonic acid which is disengaged during the saturation produces a slight effervescence, which requires attention, lest the liquor should flow over the edges of the vessel: it must be continually stirred, and the acid be added by degrees. The colouring matter, which was only held in solution by the alkali, separates from the solution as the saturation is effected; but, instead of being deposited on the sides of the vessel, it fixes itself, in preference, on the cotton, with which it has an affinity. The first washing of the carthamus can never sufficiently clear it of the yellow-colouring matter; a portion of it is always found in the alkaline solution, and rather injures the tint of the cotton which has served to collect it; but this is removed with facility by further washings. When the cotton has been well washed, it is again treated with a fresh solution of carbonate of soda; and a bath is obtained, containing only the red-colouring matter, perfectly pure. When it is used for dyeing, the stuffs are plunged into it; and, as in the former case, a sufficient quantity of lemon-juice, or tartaric acid, is added. If it is wished to separate the colouring matter as it is employed in making bunches of artificial roses, the manipulation is exactly the same; with this difference only, that the vessel does not contain any cotton on which the colouring matter might fix, and it therefore deposits itself by degrees in very minute particles: the liquor is then decanted, the precipitate is washed, and distributed into several saucers; and assumes, on drying, a kind of greenish-coppery tint, affording, by reflected light, an appearance somewhat like that of cantharides*. The rose-coloured tint is developed as soon as water is added to it. This colouring matter, mixed with the chalk of Briançon† reduced to an impalpable powder, constitutes the *vegetable rouge*, or paint. R.

* These saucers are sold in this country, in the colour-shops; and are known by the name of *pink-saucers*.

† In this country, steatite, or French-chalk, reduced to fine powder, by means of Dutch rushes, is employed for this purpose.—Editor.

LIST OF PATENTS FOR NEW INVENTIONS,

which have passed the Great Seal, since Nov. 1, 1823.

To John Rankling, of New Bond Street, in the city of Westminster, and county of Middlesex, Esq.; for a means of securing valuable Property, in Mail and other Stage Coaches, Travelling Carriages, Waggons, Caravans, and other similar Public and Private Vehicles, from Robbery. Dated Nov. 1, 1823.—To be specified in two months.

To George Hawkes, of Lucas Place, Commercial Road, in the Parish of Stepney Old Town, in the county of Middlesex, Ship-builder; for an improvement in the construction of Ships' Anchors. Dated Nov. 1, 1823.—In six months.

To George Hawkes, of Lucas Place, Commercial Road, in the parish of Stepney, Old Town, in the county of Middlesex, Ship-builder; for certain improvements on Capstans. Dated Nov. 1, 1823.—In six months.

To William Bundy, of Fulham, in the county of Middlesex, Mathematical-Instrument-Maker; for an Anti-Evaporating Cooler, to facilitate and regulate the Refrigerating of Worts or Wash, in all seasons of the year; from any degree of heat, between boiling and the temperature required for fermenting. Dated Nov. 1, 1823.—In six months.

To Thomas Foster Gimson, of Tiverton, in the county of Devon, Gent., in consequence of communications made to him by a certain person residing abroad, and of discoveries made by himself, for various improvements in, or additions to, Machinery now in use, for doubling and twisting Cotton, Silk, and other fibrous substances. Dated Nov. 6, 1823.—In six months.

To Thomas Gowan, of Fleet Street, in the city of London, Truss-Manufacturer, for certain improvements on Trusses. Dated Nov. 11, 1823.—In two months.

To John Day, of Barnstaple, in the county of Devon, Esq.; for certain improvements on Percussion Gun-Locks; applicable to various descriptions of Fire-arms. Dated Nov. 13, 1823.—In two months.

To John Ward, of Grove Road, Mile-end Road, in the county of Middlesex, Ironfounder; for certain improvements in the construction of Locks and other Fastenings. Dated Nov. 13, 1823.—In two months.

To Samuel Servill, of Brown's Hill, in the parish of

Bisley, in the county of Gloucester, Clothier; for a new mode, or Instrument, for Dressing of Woollen or other Cloths. Dated Nov. 13, 1823.—In two months.

To Richard Green, of Lisle Street, in the parish of Saint Ann, in the county of Middlesex, Sadlers'-Ironmonger; for certain improvements in constructing Gambadoes or Mud-Boots, and attaching Spurs thereto; and part of which said improvements are also applicable to other Boots. Dated Nov. 13, 1823.—In two months.

To Robert Stein, of the Tower Brewery, Tower Hill, in the city of London, Brewer; for an improved construction of a Blast Furnace, and certain Apparatus to be connected therewith, which is adapted to burn or consume Fuel in a more economical and useful manner than has been hitherto practised. Dated Nov. 13, 1823.—In six months.

To Joseph Gillman, of Newgate-street, in the city of London, Silk-Warehouseman; and John Hewston Wilson, of Manchester, in the county of Lancaster, Silk and Cotton Manufacturer; for certain improvements in the Manufacture of Hats and Bonnets. Dated Nov. 18, 1823.—In six months.

To John Heathcoat, of Tiverton, in the county of Devon, Lace-Manufacturer; for a Machine for the Manufacture of Platted Substances, composed either of Silk, Cotton, or other Thread or Yarn. Dated Nov. 20, 1823.—In six months.

To Thomas Hopper, of Reading, in the county of Berks, Esq.; for certain improvements in the Manufacture of Silk Hats. Dated Nov. 20, 1823.—In six months.

To Charles Anthony Deane, of Charles-street, Deptford, in the county of Kent, Ship-Caulker; for an Apparatus or Machine to be worn by Persons entering Rooms or other places filled with Smoke or other Vapour, for the purpose of extinguishing Fire, or extracting Persons or Property therein. Dated Nov. 20, 1823.—In six months.

To Jacob Perkins, of Fleet Street, in the city of London, and John Martineau the Younger, of the City Road, in the county of Middlesex, Engineers; for improvements in the construction of the Furnaces of Steam-Boilers and other Vessels; by which the fuel is economized, and the smoke is consumed. Dated Nov. 20, 1823.—In six months.

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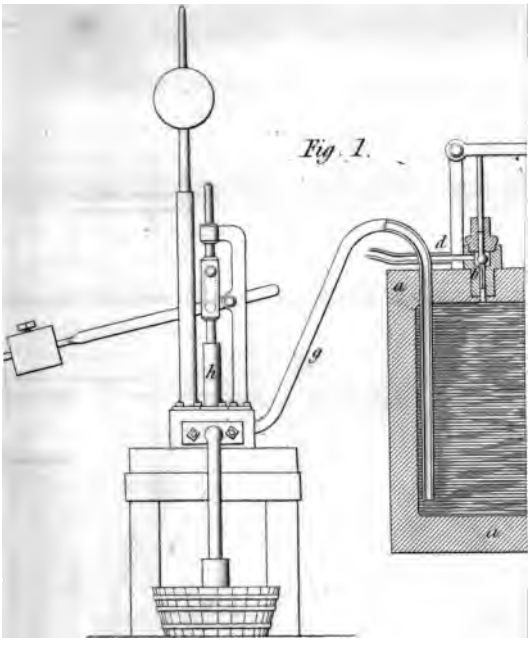

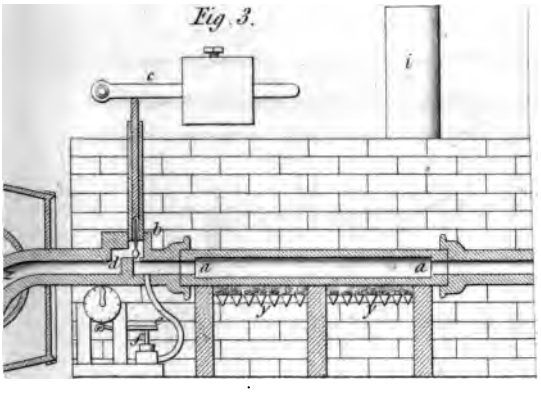

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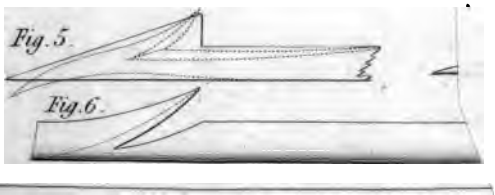

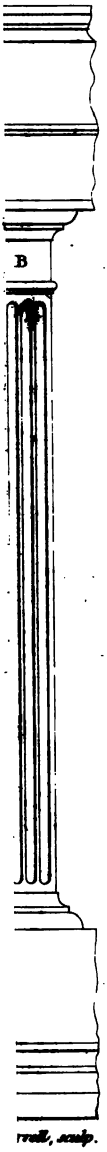

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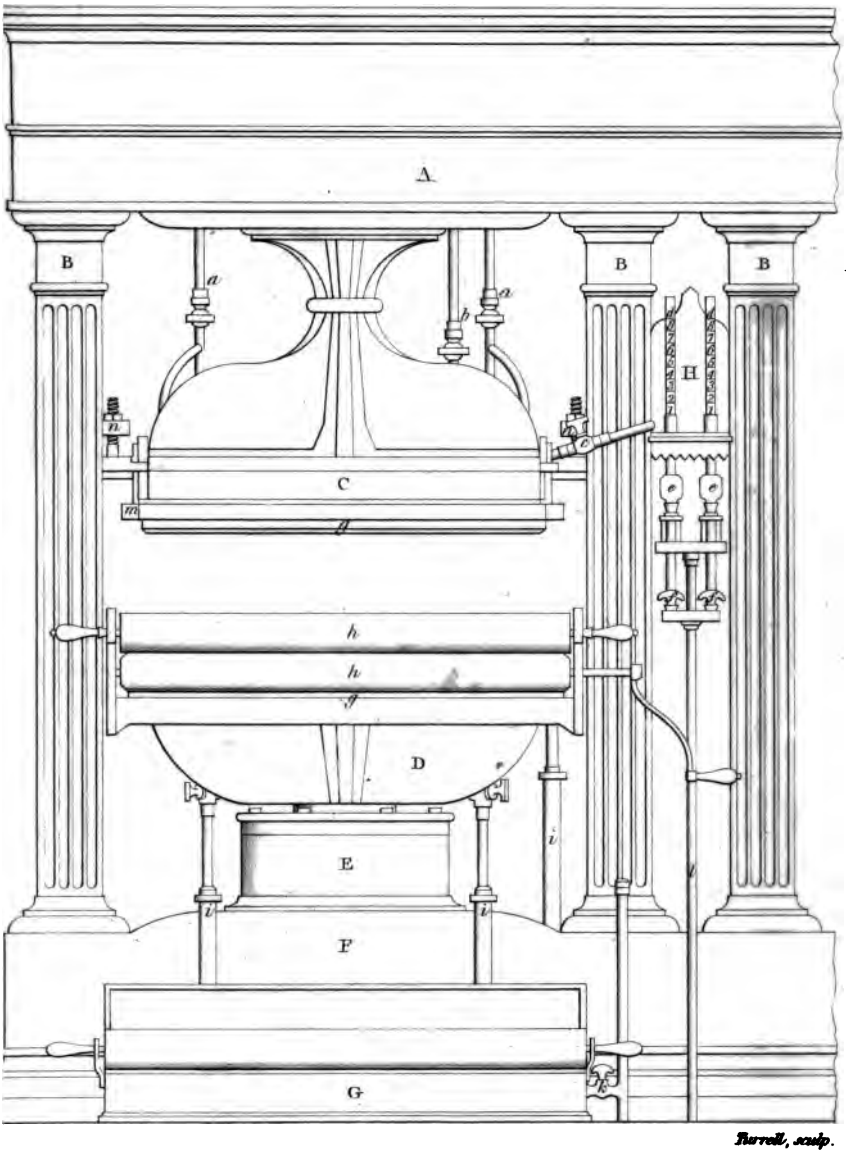

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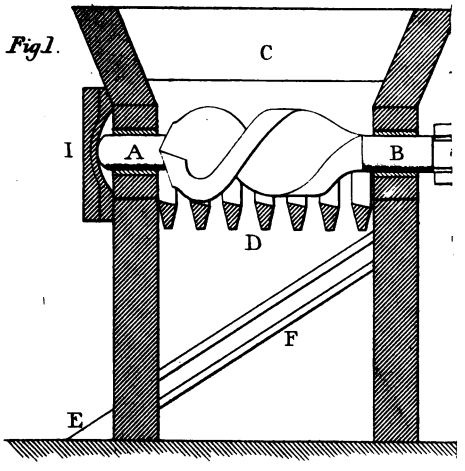

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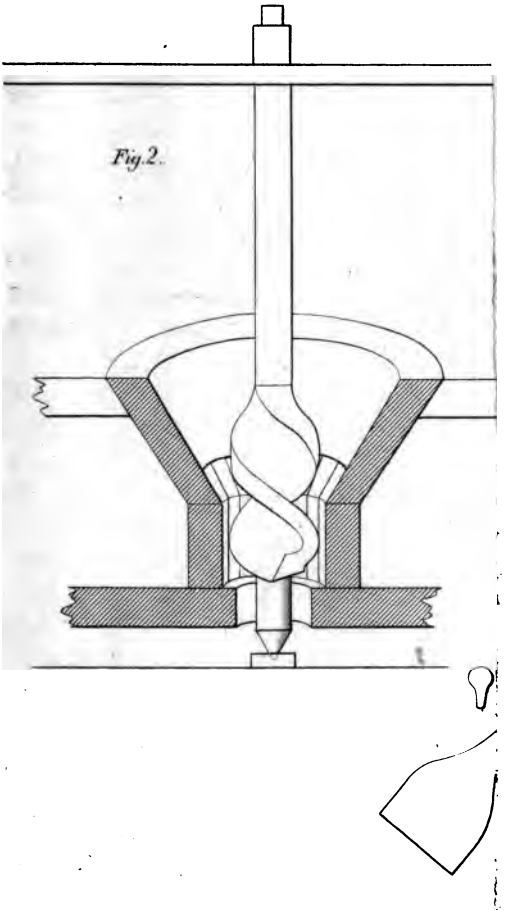

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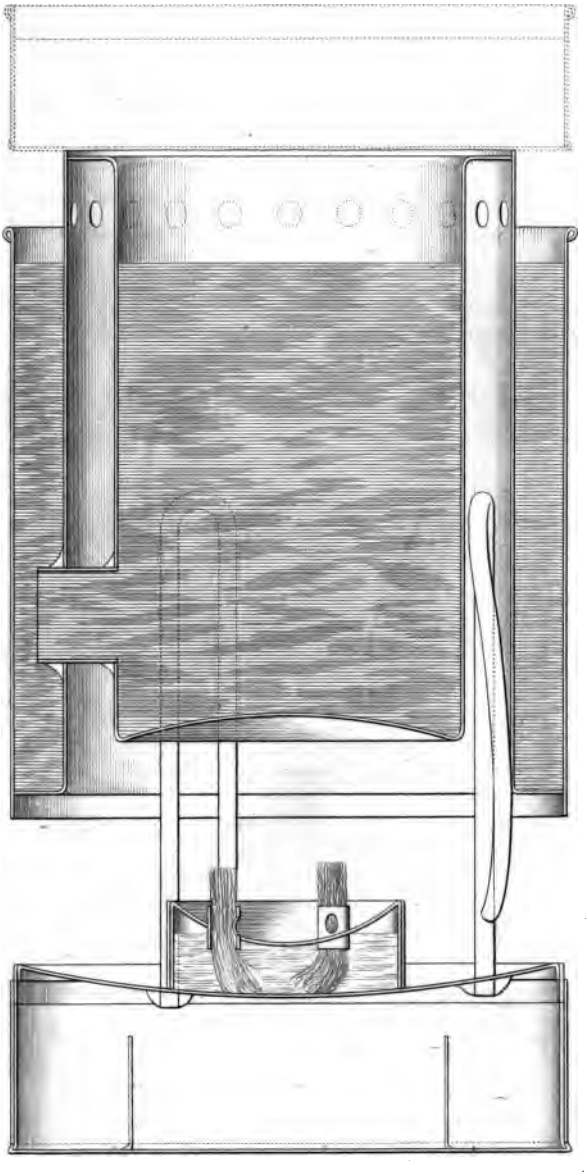

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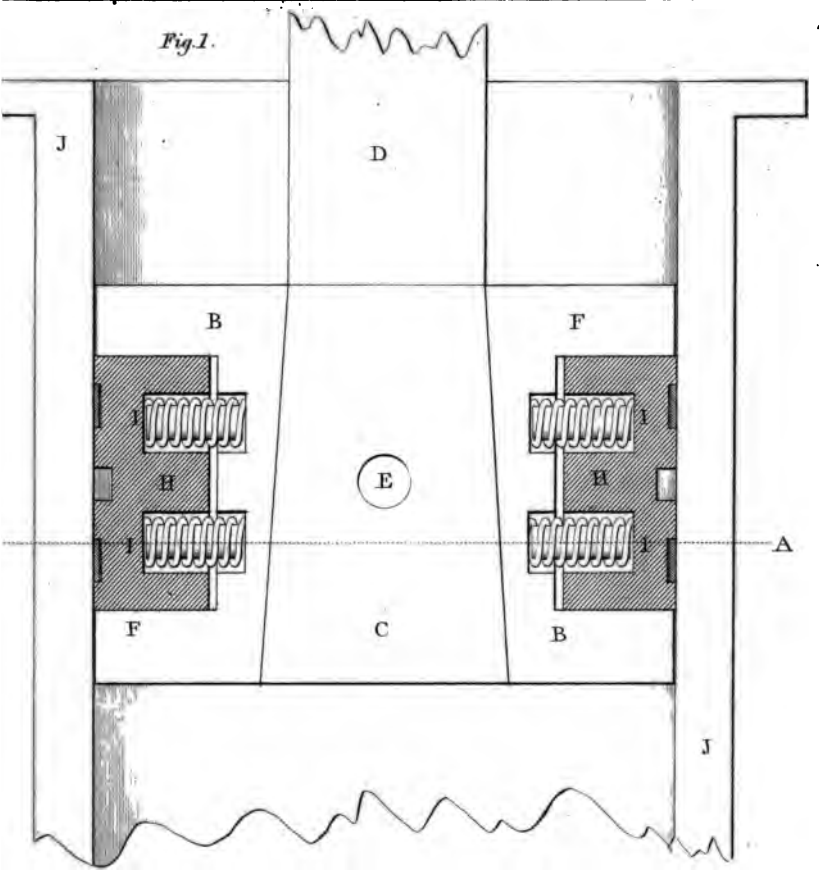

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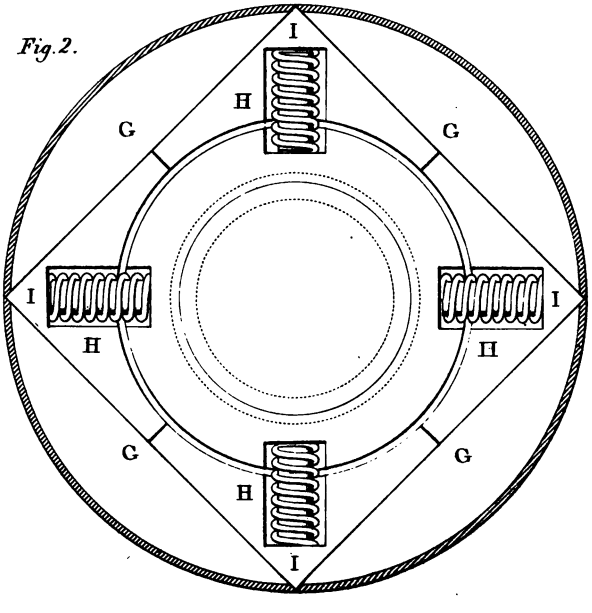

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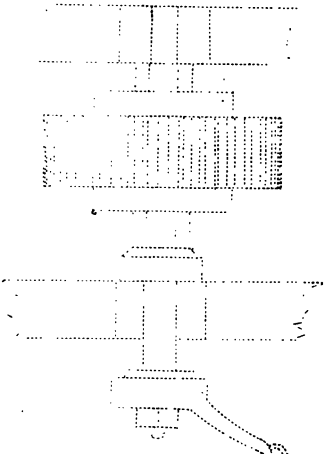

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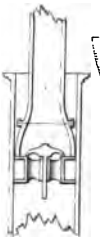

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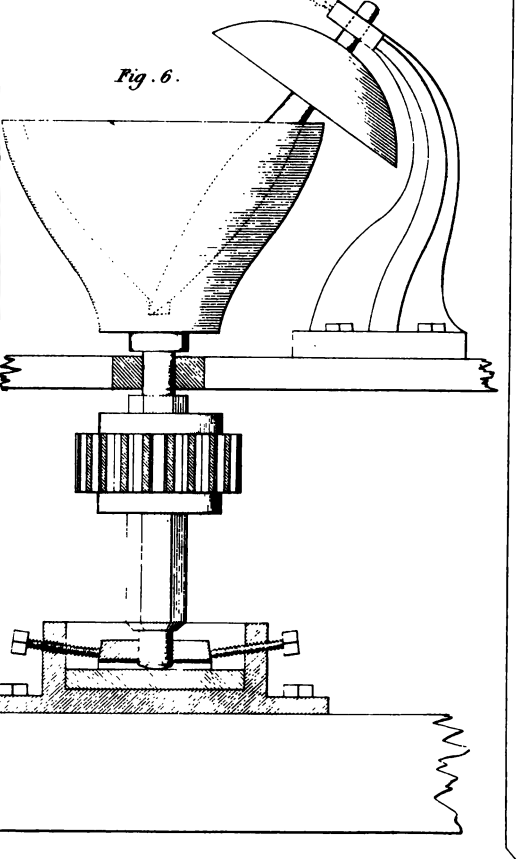

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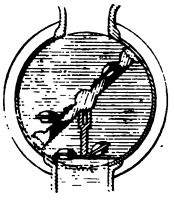

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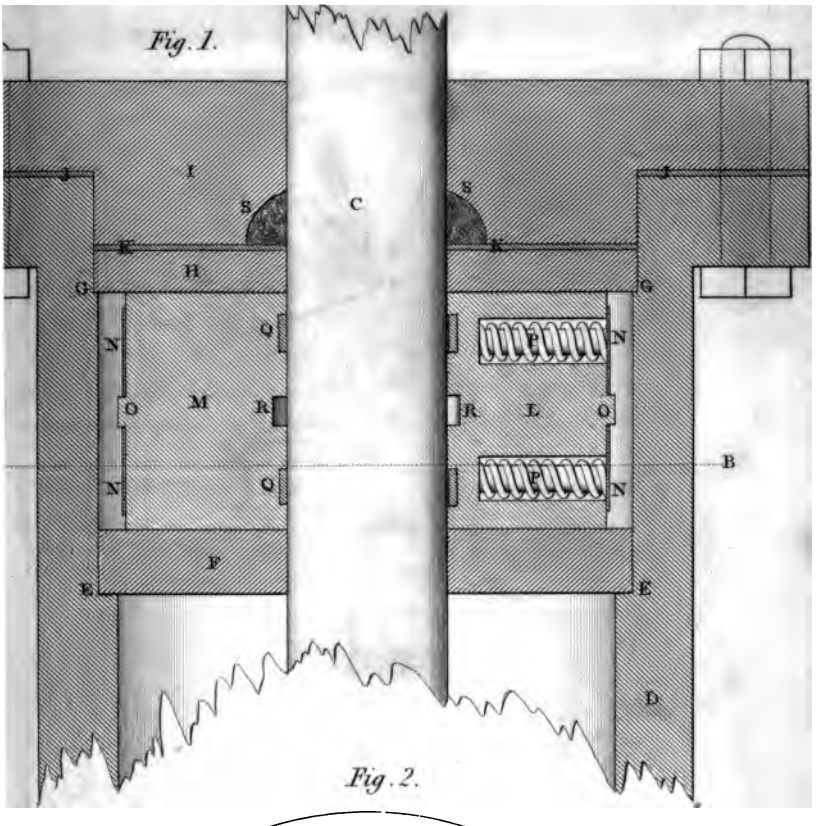

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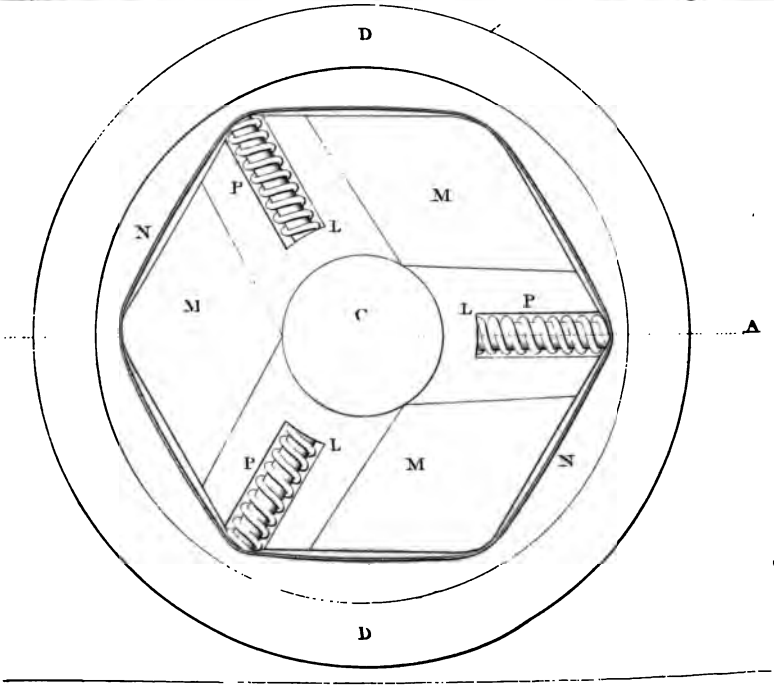

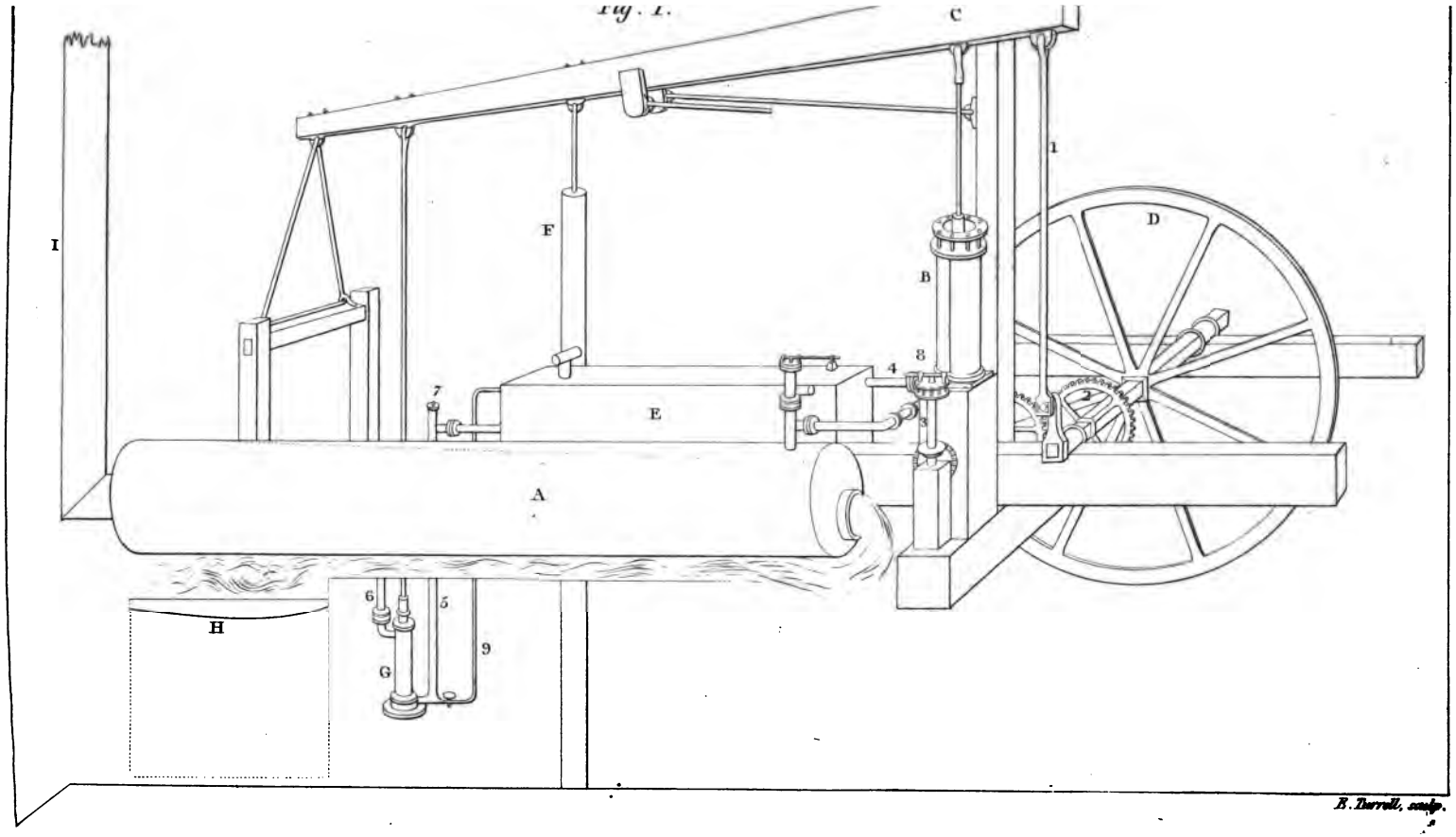
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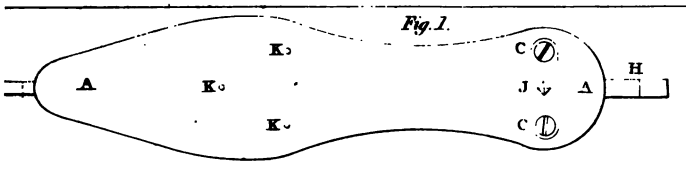

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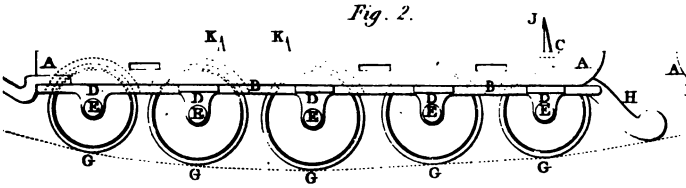

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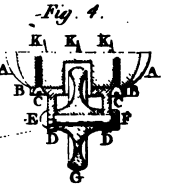

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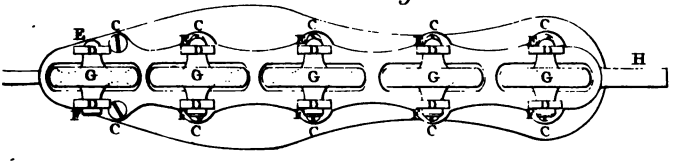

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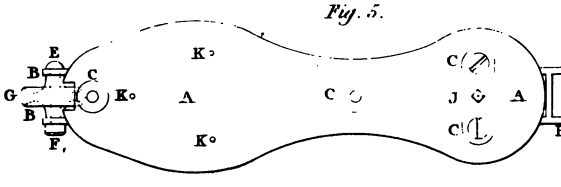

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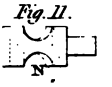

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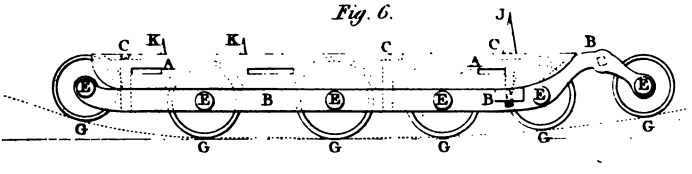

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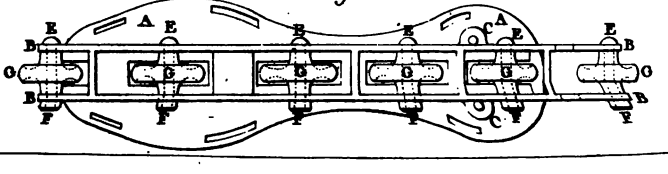

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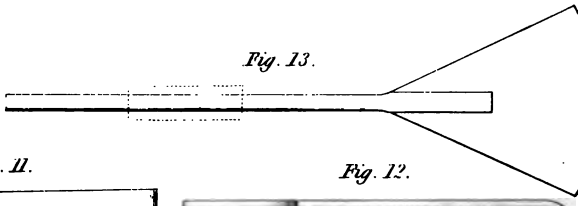
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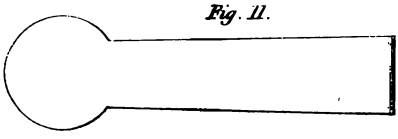
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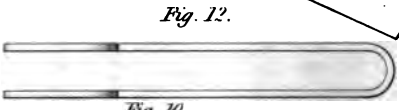
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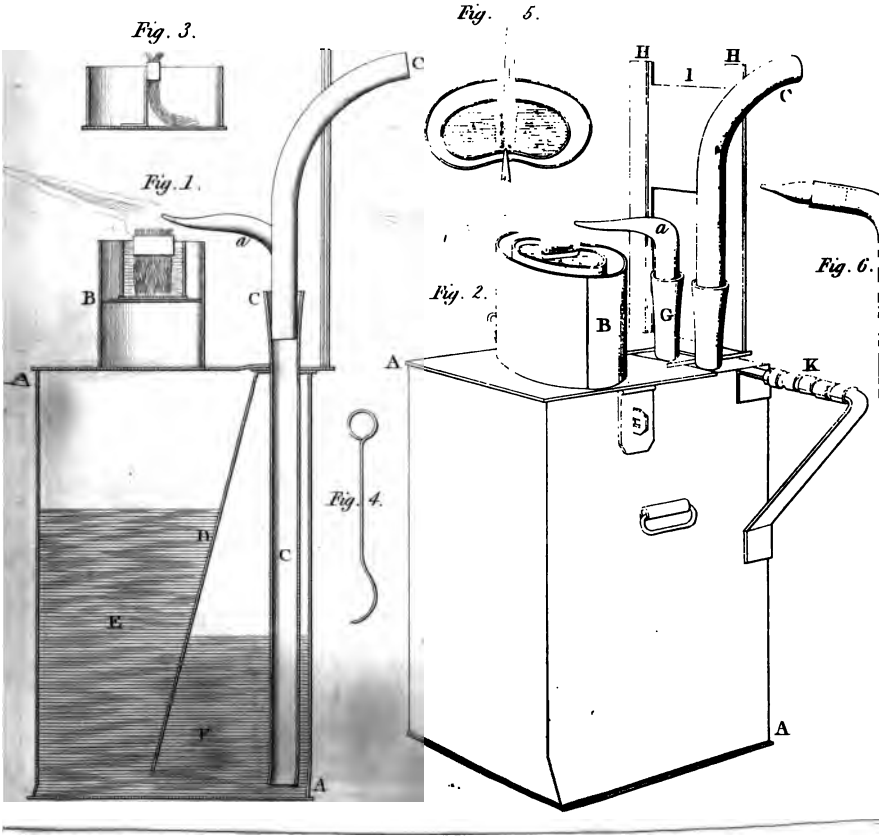
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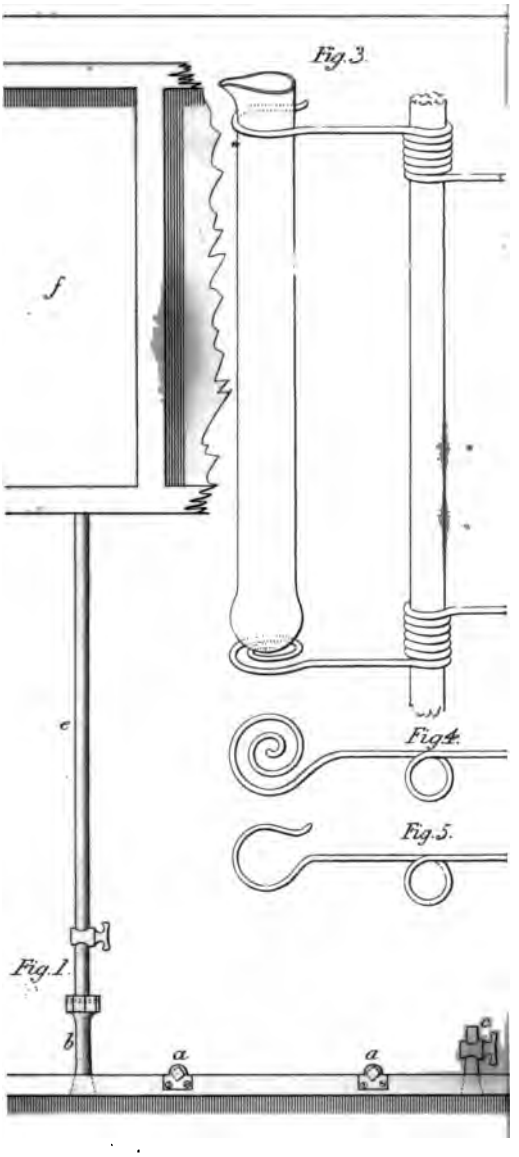
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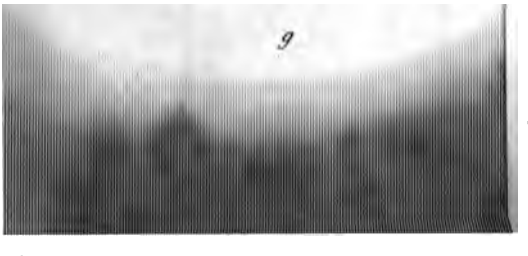
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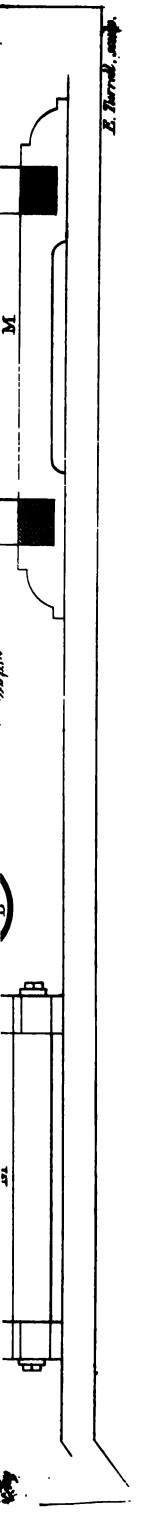
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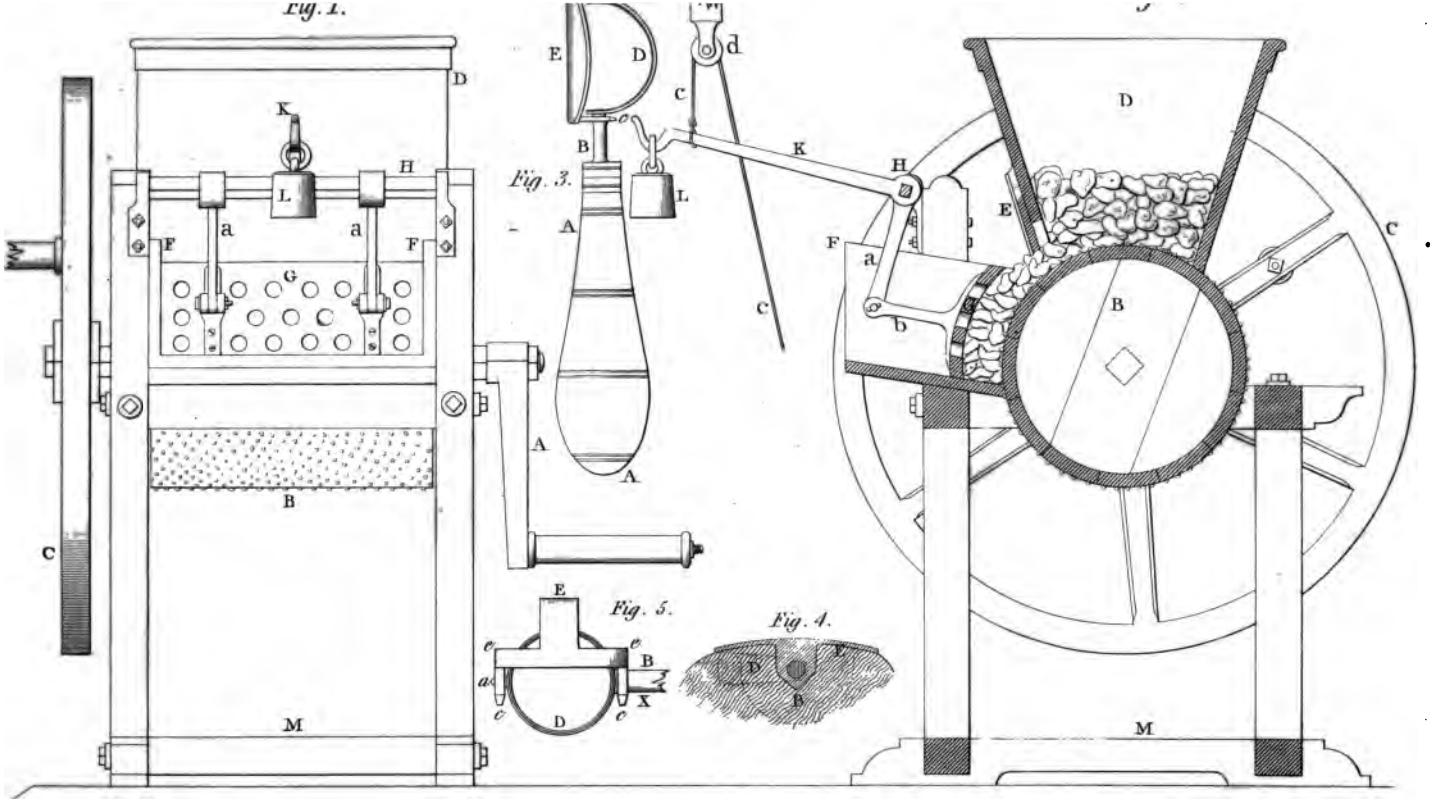
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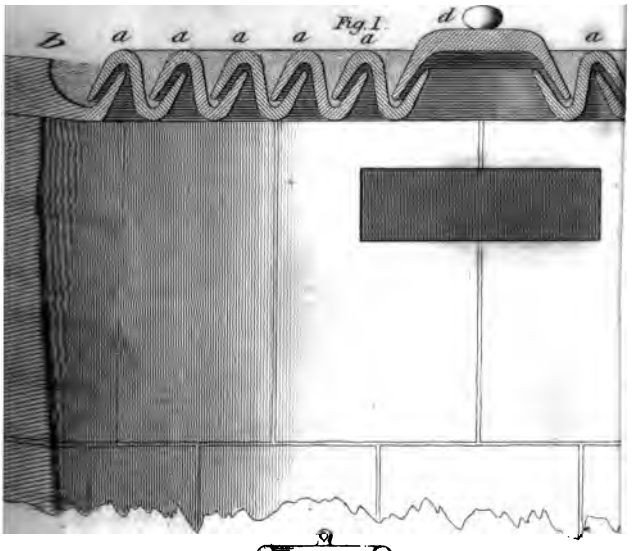

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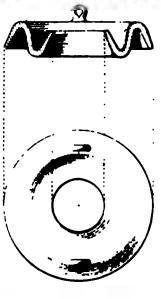
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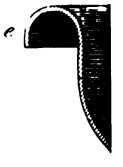

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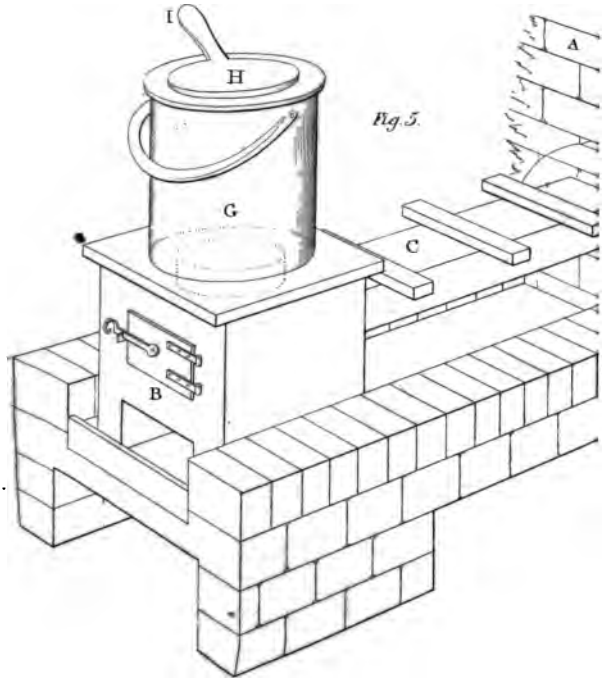
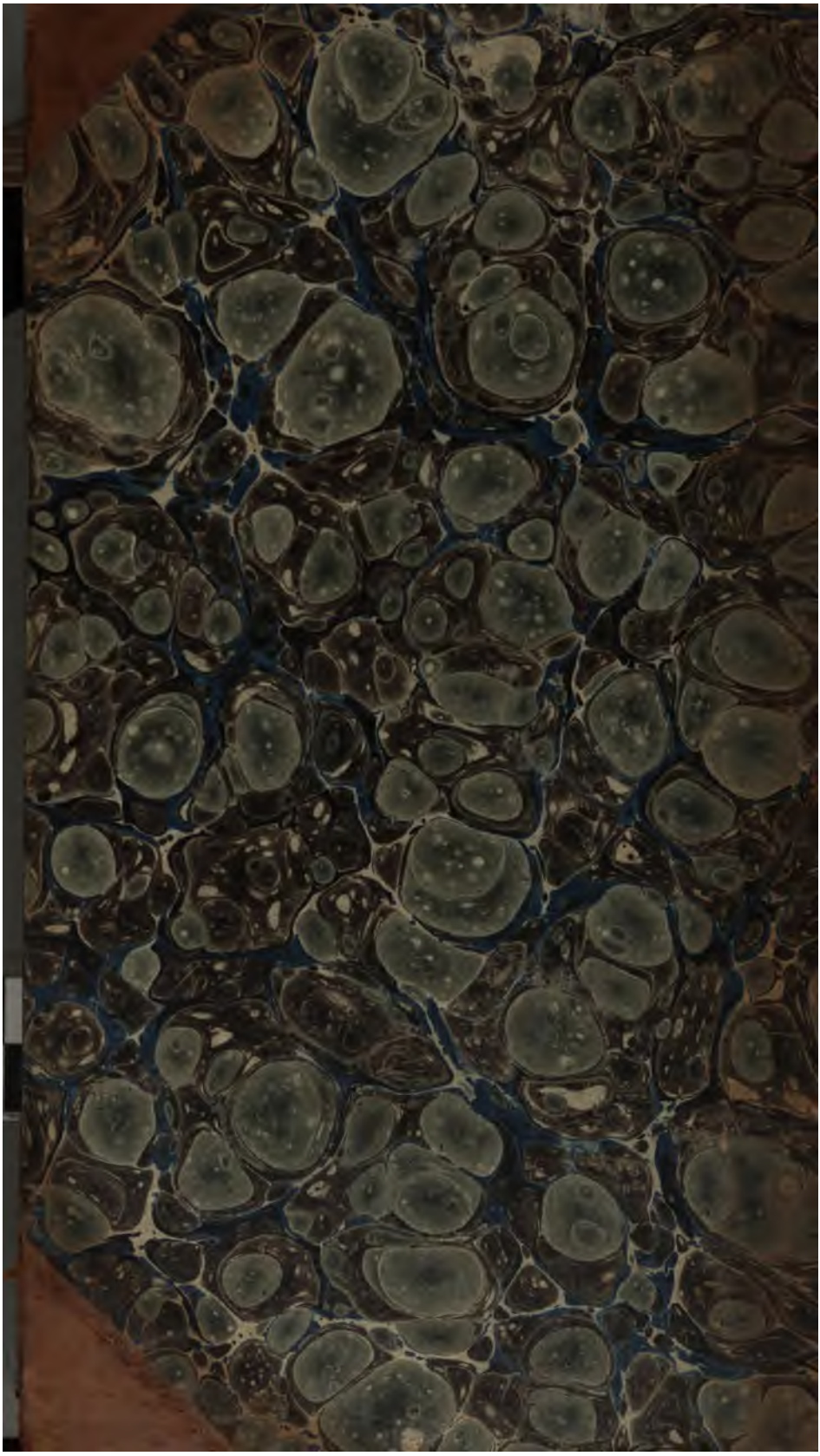
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